EDITORIAL

THE United States Bureau of Mines has established an experiment station at Bartlesville, Oklahoma, for the investigation of problems of the petroleum and natural-gas industries.

OPERATION of street-cars through the Twin Peaks tunnel at San Francisco commenced February 3, three years and three months after the contract for the construction of the tunnel was signed. The total cost of the work including rights-of-way and land damages was about $4,000,000.

PRIORITY order No. 2, prohibiting the use of open-top freight-cars for the transportation of road materials, has been rescinded and contractors and highway engineers are finding it easier to obtain the necessary supplies. One of the results of government operation of railroads will probably be that highway projects approved by the Federal officials will have no difficulty in obtaining materials.

ONE way to save fuel and help win the War is to increase the proportion of metered services in towns supplied with pumped water. A recent investigation in one Californian city showed that the average daily consumption per capita during the past year was 591 gallons, and that during July it was 881 gallons. Even when a town is supplied with gravity water, waste of water, like waste of anything else, is especially reprehensible at the present time.

COMMERCE on the Atlantic has become of such importance that we are likely to forget that we built the Panama Canal recently, and that it is now being operated. The report of Colonel Chester Harding, in charge of the canal, for the year ended June 30, 1917, shows that in spite of interference from slides during the early part of the year, 1876 vessels carrying 7,229,255 tons of cargo passed through the canal, 905 vessels going from the Atlantic to the Pacific and 971 from the Pacific to the Atlantic.

THE Ordnance Department of the United States Army needs several thousand civilian workers. Positions are now open for 400 engineers of tests, 2500 machinists, 200 drop-forgers, 300 tool-makers, 600 mechanical draftsmen, 50 gauge-designers, 1200 inspectors of ammunition, 400 inspectors of powder, and 1000 inspectors of other articles. No examinations will be held for the positions mentioned, candidates being rated upon education, training, and experience. Further information may be obtained from the United States Civil Service Commission, or at any post-office.

NAVIGATION in Pacific Coast waters is, and probably always will be, particularly hazardous because of the rocky shore, small number of harbors, and frequent fogs. It is especially important, therefore, that accurate charts should be available. Notwithstanding this fact, the proportion of Pacific Coast waters that has been surveyed accurately during the 70 years since the Mexican war is much smaller than the proportion of Philippine waters charted since the Islands were acquired by the United States less than 20 years ago. Furthermore, no systematic work has been done on the Pacific Coast during the past 21 years. Not only are the soundings in many areas insufficient for safety of vessels, but information is also lacking about the prevailing currents, which may affect a ship's course materially. What gives particular force to the above information regarding this branch of our unpreparedness is the fact that it comes not from a Chamber of Commerce, or even from some State official, but is taken from an official publication of the United Coast and Geodetic Survey, written by Mr. E. Lester Jones, superintendent of the Survey.

REVISION of the constitution of the American Society of Civil Engineers is to be submitted to the members by letter-ballot. Probably the most important change proposed is in the qualifications for Member of the Society. The requirement for five years of responsible charge of the work is to be limited to "the construction of engineering work of high grade." No matter whether an engineer has attained eminence in research, on the Federal or State surveys, or in the operation of engineering works, if he happens to have had less than the required five years of experience in charge of construction, he is to be debarred from the highest grade of membership in the Society. Other changes relate to the disciplining of members, the status of the Secretary, and methods of amending the constitution. The change in qualifications for membership, however, should alone be sufficient to defeat the revision. Furthermore, this is not a good time to make fundamental changes in the constitution, since many members are either in the Army or so much occupied with other war activities that they can pay little or no attention to the affairs of the Society. These considerations seem to have had weight at the annual meeting of the Society held last month, where a resolution was carried that "the sense of the meeting" was opposed to the adoption of the revision.

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MARK L. REQUA has been appointed Federal Oil Administrator. In the words of the spellbinder, 'Mr. Requa needs no introduction, etc.,' but it is interesting to note a few of the circumstances that make his appointment particularly fortunate. One of the principal duties of the new Administrator will be either to fix prices for petroleum and petroleum products or else to decide that price-fixing is unnecessary. As far back as 1910, when the energies of most Californian oil-men were concentrated on development irrespective of costs, Mr. Requa's voice was as one crying in the wilderness, calling attention to the fact that, according to the most elementary principles of accounting, most of the operators were selling their oil for less than the cost of production. Later, as chairman of the committee that prepared the valuation preparatory to the unsuccessful attempt to merge all the members of the Independent Producers' Agency into one company, Mr. Requa was able to add to his knowledge of the costs of oil-production. If he decides that price-fixing is unnecessary, that decesion will be based on good and sufficient reasons. If prices are fixed, they will be such as to encourage the maximum of production without injustice to consumers. One thing is certain, there will be no such fiasco as the one attending the fixing of coal prices.

'CHARGING all the traffic will bear' is usually both unjust and unwise. The Postoffice Department seems to be determined to charge the periodicals not merely all the traffic will bear, but more than it will bear. In place of a universal postage-rate for the entire country, a system of zone rates has been approved and will soon go into effect that will raise the present rates from 50 to 900%, according to distance. There might be some excuse for this increase if it were known that the actual cost of transporting the periodicals corresponded approximately to the new rates. On the contrary, there has never been any complete investigation of the cost of handling the various classes of mail. No one knows how much it actually costs to carry periodicals, but there is every reason to believe that it is not anywhere near as much as the new rates. Even if an investigation should show, as it probably would, that the cost of handling periodicals was somewhat higher than the present rates, changes in rates should not be made without careful consideration. These are times when we particularly feel the need of a united nation. The periodicals of national circulation have done more to make the Nation united and to keep it united than any other one force. In fact, we may safely say that success in the War would be seriously jeopardized if the national periodicals were suddenly to be swept out of existence. And that is approximately the effect that the zone rates would have. The bill providing for these rates should be repealed before it goes into effect. It is significant that the bill was passed not on its own merits, but was made a 'rider' on the War Revenue Bill, and carried in that way.

Labor Conditions

The report of the first survey made under Government auspices of industries engaged in war work has recently been made public by the United States Employment Service. This report covers the State of New York and was made by Miss Marie L. Obenauer. No statement is made whether or not such surveys are being made for other States, but it is unfortunate that similar data have not already been made available for the entire country. However, the report is valuable as far is it goes, and while conditions in New York differ materially from those on the Pacific Coast, many of the data contained in the report are of interest to Western readers.

In the course of the survey, 500 factories filling war orders and employing 261,117 persons were visited. Of this number, 176 factories are calling for additional workers, the total number desired being 34,155, or about 13% of the present force in the whole 500 factories. Skilled male labor is required in three-fourths of the cases, unskilled male labor in one-seventh, and female labor in the remainder. Of the women required, only about 300 are to take the places of men. The classification of the industries requiring the largest number of additional workers and the number required is as follows: aeroplanes and sea-planes, 13,474; ordnance and ammunition, 9667; iron and steel castings and forgings, 2056; scientific instruments and optical supplies, 1755; knit goods, 1025; electrical apparatus and supplies, 759; needle trades, 708; machinery, 447; tools and hardware, 417. On the other hand, factories in the following industries are reducing their force, even though they are directly or indirectly engaged in war work; garment trades, carpets, fine leather, fine gloves, trunks, high-grade woodwork, wagons and parts, mattresses and spring-beds, typewriters, brass and bronze castings, tin cans, and certain classes of machinery. Evidently the readjustment to war conditions now taking place will require considerable guidance if a great deal of unemployment is to be avoided. This readjustment is rendered more difficult in the case of New York because the factories needing the most labor are in the western and central parts of the State and those reducing their working-forces are in the eastern part. In this regard the report makes the following statement:

"To effect a distribution of labor in strict accord with the needs and character and relative importance of the war industries, the Department of Labor must have a responsive touch with each of the Federal departments making demands upon industry for munitions and other supplies for the fighting forces. . . . The very morning upon which the Surgeon General was quoted in the press as reporting 200 cases in one camp-hospital as being without beds, a Department of Labor agent sent in a schedule from a mattress and spring-bed firm that was laying off its labor because of lack of orders."

Readjustment to changed working conditions is also hindered by lack of housing accommodations.

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REVIEW OF THE MONTH

PRODUCTION of portland cement during 1917 in the United States exceeded all previous records, amounting to 93,554,000 barrels, or 1,500,000 barrels more than that for 1913, until now the record year. Shipments were not quite so large, the result being an addition of 2,800,000 barrels to the stocks at the mills. On the Pacific Coast, production was 7,656,000 barrels, and shipments 7,026,000 barrels, a slight increase in both cases over the record in 1916.

MOTOR-TRUCK transportation for handling parcel post has recently been established on several routes in the vicinity of Washington, D. C. Plans have been completed and bids are now being received for operating a system of routes throughout the country, having an aggregate length of 3000 to 4000 miles. On the Pacific Coast, routes are to be established between San Francisco and Sacramento and between Redlands and Los Angeles. The routes are from 50 to 125 miles long. They are arranged particularly with the idea of assisting transportation of food, and consequently reducing its cost.

THE Walsh-Pittman bill for leasing oil and coal lands in the public domain passed the United States Senate by a vote of 37 to 32. It has still to come before the House of Representatives. Under the provisions of the bill, a prospector may receive a permit to explore a tract of 640 acres. If he discovers oil on the tract he is to receive patent to 160 acres and a preference right to lease the remaining 480 acres. No individual or corporation is to be permitted to lease more than 2560 acres, a pathetic reminder that, in spite of the lessons of the past few months the old prejudice against monopolies dies hard. With certain restrictions, companies now operating on unpatented land, whether withdrawn or not, if their claims for patent are not valid, may obtain leases to the land that they occupy. At the time of going to press, no vote had been taken on the Swanson bill for the condemnation of private property within naval reserve No. 2 in the Buena Vista hills.

OIL-PRODUCTION in California during 1917, according to the final figures, amounted to 97,800,000 barrels. Shipments were 108,800,000 barrels, necessitating drawing 11,000,000 barrels from stocks, or 30,000 barrels per day. Production was larger than any year except 1914, when the production was 102,800,000 barrels. Since the 'shut-in' production during 1914 was probably about 6,000,000 barrels, it is safe to say that had all the wells existing in 1914 been pumped to the fullest extent, they would have been barely able to satisfy such a demand as prevailed in 1917. Nearly 800 wells were completed during 1917, but the total production was only 6,000,000 barrels more than in 1916. At this rate, 1600 wells must be completed during 1918 if production is to overtake consumption, provided also that consumption does not increase at all. Considering the present conditions as to labor, materials, and land, the completion of 1600 wells within the year appears to be impossible.

RAILROAD construction in the United States during 1917 amounted to only 962 miles, less than in any year since the Civil War, except 1915, when 933 miles was built. The net gain in mileage was even smaller, since 942 miles was torn up. Applications are now pending before State commissions for the abandonment of 396 more miles of line. This does not indicate that 1338 miles of railroad has suddenly become unprofitable to operate, but rather that this mileage has for some time been unprofitable or only slightly profitable, and that the present high prices of second-hand materials, particularly scrap-iron and steel, have made it more profitable to 'junk' the equipment than to continue operating. The old policy of following 'the grass-roots for grade and the county subsidies for alignment' has caused the birth of many monstrosities miscalled railroads. Other lines besides those already abandoned could be spared. Further abandonment of railroads during the War will depend on the details of the plan for Federal control. It is hardly likely that any railroad actually taken by the Government will be abandoned, but if the announced intention of the Director of Railroads not to take over short lines that are unnecessary to the general plan is followed, some of these short lines will be forced into bankruptcy.

'COAL-LESS MONDAY' has taken its place among our various weekly '-less' days. Besides the four-day shut-down from January 18 to 22, manufacturers east of the Mississippi river, except a few special classes, must refrain from burning fuel on Mondays until March 25, unless the order is rescinded before that time. It is lamentable that a condition requiring such drastic measures should have been permitted to come to pass. Here we have a War on our hands that requires the best efforts of all our people, working at their highest efficiency, and yet a large number of those actually employed are compelled to reduce their working time one-sixth. If this could not have been prevented, it could at least have been foreseen long enough to have enabled both employers and workmen to prepare for it. Neither

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is it certain that, had there been better co-ordination between the various Federal departments and had a more liberal attitude toward the coal-operators governed the fixing of prices, the whole unfortunate mess might not have been avoided. Be that as it may, the present situation required such an order, and we may as well make the best of it. Here on the Pacific Coast, the effect, either direct or indirect, is small. Incidentally, this latter fact furnishes an interesting field for the student of the law of compensation. For the past two or three years business in most lines has been better in the East than in the West, but now the same causes that have made for activity in business there have produced the congestion that has made it necessary to 'slow down.' In the West, business has not been quite so active, therefore no congestion has followed, and we can continue our pursuits as before.

STUDENTS of municipal ownership of public utilities will be interested in the financial report of the Municipal Railways of San Francisco for the year ended June 30, 1917. The operating revenue was $1,477,910.59, and the net revenue, after deducting interest on bonds and depreciation, was $21,668.17. However, this statement does not take into account the 'comparison charges,' consisting of the taxes that the Municipal Railways would have to pay if it were a private company, amounting in all to $125,576.19, and leaving a deficit for the year of $103,908.02. This is the size of the deficit as shown by the books, but we know that there is a tendency in municipal accounting for items that should be charged to the utility to be charged to some other department. This may have been entirely in good faith, but the taxpayer suffers. There is no means of knowing whether this has been the case with the Municipal Railways of San Francisco, unless perhaps the Bureau of Municipal Research can find out. It should be remembered that the management of the Municipal Railways has been competent and honest, and that there has been little or no 'graft' or even waste in the construction or operation of its lines. Probably the main reason for the poor financial showing has been the construction of lines in places where they would do the most good politically, rather than where they would be the most profitable. This would open the question of the advisability of a municipally-owned utility being managed to develop the city rather than directly for profit, were it not for the fact that some of the most unprofitable lines were constructed in territory already served by the private competing company.

'DAYLIGHT-SAVING' is once more under discussion. The plan of setting the clocks one hour ahead during the summer months originated, we believe, in Great Britain, where the variation in length of days is considerably greater than in the United States. However, a number of factories and a few cities in this country have tried the plan, and have professed themselves satisfied with it. The latest recruit to the daylight-saving cause is the Medical Board of the Council of National Defense, which has passed a resolution endorsing the Calder bill recently passed by the United States Senate and now being considered by the House of Representatives. Daylight-saving accomplishes an obvious thing by a roundabout method because custom stands in the way of the direct method. There is not, and never has been, any need of such a plan in the country districts. The farmer has always arranged his working-day to suit the daylight and the amount of work to be done. Also on many large construction jobs the working-day is varied to suit climatic and other conditions. In cities, of course, conditions have been different, and the proposal to fool ourselves by setting the clocks ahead, instead of simply starting to work on hour earlier by the clock is the result. The principal economic advantage expected is the saving of fuel resulting from the saving of light. Where the main source of power is hydro-electric, the saving would probably be small, since the peak-load would be reduced only slightly, if at all. There is also to be considered the possible sociological advantage to the worker of an extra hour of daylight at the close of his working-day. This will be a real advantage if he employs it to good purpose.

CONSOLIDATION of the three principal power companies serving northern and central California, the Pacific Gas & Electric Company, the Great Western Power Company, and the Sierra & San Francisco Power Company has been accomplished. The object of the consolidation is to save fuel-oil by an interchange of service between the hydro-electric plants of the different companies. This will permit closing entirely some steam-plants formerly in service, and a reduction of fuel-oil consumption at the others. The plan is to remain in effect until the end of the War, and as much longer as may be deemed in the best interests of the public, which latter provision is likely to mean that the plan will be permanent. The public is not so much afraid of monopolies as it used to be. Besides connecting the distributing system of any one company with the transmission lines of other companies, plans are now under way for connections between the main transmission-lines of the three companies so as to permit further reductions in the peak load of each company. The amount of this kind of work that can be done at the present time will probably be limited by the amount of construction material available, but, in any case, will be considerable. The companies included in the merger use 5500 barrels of fuel-oil per day now, and this quantity can be reduced materially. Similar plans are being considered in southern California, where the companies use 1000 barrels of fuel-oil per day at the present time. The most promising field for saving there would be in arranging to use the hydro-electric plants of the city of Los Angeles to serve consumers who are now receiving steam-generated electricity from the Southern California Edison Company and the Los Angeles Gas & Electric Corporation.

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DISCUSSION

Carbon Monoxide in Traffic-Tunnels

The Editor:

Sir—San Francisco can profit by the experience and investigations made in New York regarding tunnels in place of a bridge or bridges over the Hudson river. While other determining factors enter into the problem of a crossing for San Francisco bay, the question of ventilating a tunnel for automobile traffic is important, provided other factors should ever cause tunnels to be considered seriously.

The plan proposed some months ago for a traffic-tunnel under Hudson river had the approval of a board of eminent engineers, which considered the problem of proper ventilation to be a simple one, holding that it would only be necessary to reduce the carbon monoxide content to 0.20% to make the tunnel safe.

In this connection a letter appearing in the 'Scientific American' for August 4, 1917, entitled 'An Engineering Chimera,' from which the following quotations are taken, is of interest:

"Tests by Marks, Schröter, Robinson, Price, and the Automobile Club of America, made independently and on engines of many types, give figures for gasoline consumption per horse-power hour, ranging from 0.6 to 1.04 lb. Since the reduced speed necessary in such a tunnel as that proposed makes for loss of efficiency and increase of fuel consumption, we may without fear of overstating our case take the average of these figures, which works out 0.75 lb. per horse-power hour.

"Your own motor-truck editor, Pagé, has fixed the amount of air necessary for the combustion of a pound of gasoline at 16 lb., a figure in good accord with those given by others. We have then 17 lb. of exhaust gases, which are given off at a temperature of about 600°F. If we assume that the mixture is of substantially the same density as the air itself, and that its permanent temperature while it remains in the tunnel is some eighty-odd degrees—certainly this leaves us well within the facts—the 17 lb. will occupy something like 234 cu. ft. So we have exhaust gases about 175 cu. ft. in volume per horse-power hour.

"These gases contain both carbon dioxide and carbon monoxide. Authorities differ as to how much of each may be expected. Clerk, Schröter, and Robinson give from 9.9 to 13.8% CO_2, with an averaged statement of 11%. Working the thing out by chemical formula on the hypothesis of perfect combustion supports this figure.

"Perfect combustion, however, is never attained; and it is this fact that leads to the presence of CO in the exhaust. Clerk finds this insidious poison in a ratio ranging from 2.4 to 6.9% of the total volume of the exhaust. The Royal Automobile Club tested 12 cars and obtained four results below 2% and eight above that figure, exact values not stated. Reliable observers have reported as high as 15% CO. An elaborate series of tests made for the Public Service Corporation in connection with the present tunnel project showed invariably more CO than CO_2 in air vitiated by the operation of motor vehicles. The same chemical calculation already mentioned shows that this occurs when the dioxide content falls to 6½% or less of the exhaust and the monoxide rises to 7½% or more. All things considered, it would seem that an estimate of 7% monoxide would certainly be a reasonable minimum.

"We may safely take the average horse-power of all cars using the tunnel as 15. Then we have 2625 cu. ft. of exhaust gases per car per hour, or 44 cu. ft. per car per minute. Ignoring all other impurities, this gives rise to 3 cu. ft. of CO per car per minute. It is contemplated that vehicles pass in a double line under 60-ft. headway throughout the 5500-ft. length of the under-river section in the tunnel at once, generating 540 cu. ft. of carbon monoxide per minute.

"Air in the tunnel must under all circumstances be bad, in comparison with outdoor air. Moreover, there will be many occasions when the proper headway will not be observed. And in all our estimates we have been very conservative indeed. There seems no more reason for omitting the factor of safety here than in any other engineering proposition, especially since we shall otherwise ignore the generation of carbon dioxide and marsh gas in the tunnel. So let us add 33⅓%—a very moderate safety factor—and agree that we must be prepared to meet the generation in our tunnel of 720 cu. ft. of monoxide per minute. We must do this by ventilation; we must ask how fast it is necessary to introduce fresh air into the tunnel to keep the monoxide at a safe dilution. This in turn involves determination of the safety limit in CO content.

* * * * * *

"Haldane has pronounced 0.1% of CO to be dangerous, with recovery possible, 0.2% to lead to unconsciousness, 0.3% to be rapidly fatal. Glaister's monumental treatise on gas-poisoning devotes over three hundred pages to the effects of carbon monoxide, discussing the many serious diseases—arteriosclerosis, paralysis, pneumonia, insanity, etc.—of which it is a direct cause. Carpenter tells us that 0.06% brings on suffocation in 47 minutes, 0.12% poisoning in 7 minutes, and 0.29% death from convulsions in 2 minutes. * * *

"In view of all the findings which I have detailed, in view of the facts that the legal limit of CO_2 in 21 States is 0.1%, and in 10 States 0.07%, while CO is a poison many times more deadly than the dioxide, I do not see that it is possible to consider as satisfactory any prop-

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sition which involves dilution of the monoxide in the tunnel with less than 2000 parts fresh air to one of the poison. Ventilation, in other words, must reduce the monoxide content of the tunnel atmosphere to 0.05%. For one thing, it is certain that with ventilation currents and eddies, with badly operated cars, with air-currents caused by the traffic, with traffic tie-ups and traffic congestion, with carbon monoxide slightly lighter than air and carbon dioxide somewhat heavier—with all these complications, it is certain that diffusion will not be perfect, that no matter what degree of attenuation of the CO is adopted, there will constantly be places in the tunnel where that degree is notably exceeded. It is even possible that 0.05% CO in the entire tunnel might not be safe; certainly no greater proportion would be so.

"With an elliptical cross-section of 32½ by 22½ ft., the sectional area of the tunnel is something like 575 sq. ft., and the volume of the 5500-ft. bore between the main shafts is 3,160,000 cu. ft. At 0.1% we must recognize that the CO content begins to be immediately dangerous. But at the rate of 720 cu. ft. per minute, it would be only four minutes after the tunnel began to be operated at full capacity before this condition would be reached, provided there were no ventilation at all. In less than an hour the tunnel air would contain 1% monoxide, which of course would be instantly fatal.

"It is then in order to see what is involved in adequate ventilation. To supply 2000 volumes of fresh air to one of monoxide would entail the introduction into the tunnel of $2000 \times 720 = 1{,}440{,}000$ cu. ft. of air per minute. It is proposed to have a duct with a section of 52 sq. ft., and to admit one-half the air at each shaft. The required velocity of air in the duct would then be $720{,}000 \div 52 = 13{,}800$ ft. per minute, or 160 miles per hour! This* would necessitate the use of 32,000 hp. Adding 50% for the approach tunnels gives 48,000 hp. for the entire ventilation-scheme. At an annual cost of $50 per horse-power this would come to $2,400,000. It is not necessary to state that this is equivalent to interest at 5% on $48,000,000 in order to make it plain that such an absurd charge could not possibly be borne.

"Even if we are to give these gentlemen the benefit of every doubt, and concede the possibility of ventilation, using the tunnel bore itself as a duct—a risky engineering proposition, at best—the matter is not greatly improved. We must now admit all our air at one end and pass it through to the other shaft; and to do this we must fill the tunnel with a blast of wind blowing approximately thirty miles per hour! Even so, the cost is still prohibitive, to say nothing of other obvious drawbacks.

"Accordingly, I reach the conslusion that a tunnel beneath the Hudson river for motor traffic is an engineering impossibility."

An editorial in the same issue calls attention to the prediction of the 'London Lancet' that carbon monoxide is likely to become the terror of modern life and concludes with the following paragraph:

*Kent's 'Mechanical Engineers' Pocket Book,' P. 531.

"From the standpoint of the prospective users of the proposed tunnel there is perhaps nothing to get excited about in the Public Service plans. It is plain enough that the tunnel could not be used for automobiles, and that accordingly the proposition to kill off our chauffeurs and truck-drivers with all sorts of organic disorders is being made with no real threat of eventual execution. But the vehicular tunnel, being a public utility, is, if it ever gets built, to be financed through an arrangement which in the last analysis reduces to construction with the taxpayers' money. Accordingly, first and last, the taxpayers have a paramount interest in the matter. If the tunnel be built, they will pay for it, regardless of whether it can be used for automobiles. Consequently, all facts in the matter should be put before them without reserve. Those responsible for the report which we join our correspondent in condemning should know, if they do not, that the statements upon which we have based our judgment are facts. We hesitate whether to condemn more strongly their action in ignoring these facts and the extraordinary levity with which they dismiss the work of experts in the field of gas poisoning, or their offense against the public at large in promulgating their own findings in support of such a wholly questionable undertaking. On both grounds they lay themselves open to the severest criticism."

Now comes a plan, suggested in the New York daily newspapers of December 17, for an automobile-truck tunnel to relieve the freight congestion in New York harbor, and an eminent engineer endorses it, dismissing the question of ventilation as being too unimportant to need serious discussion.

We know that where arsenic is used in the arts the workers gradually become poisoned, and that kidney disease and even paralysis result. It seems probable that the health of constant users of subways and tunnels will be affected seriously even though gradually. We must admit that a tunnel with even a seemingly negligible proportion of carbon monoxide is dangerous.

The impossibility of building a tunnel under San Francisco bay that would provide adequately for automobile traffic is therefore evident.

CHARLES EVAN FOWLER.

New York, December 18.

ELECTRIC LOCOMOTIVES

According to J. V. Dobson in 'The Electric Journal,' exclusive of mining and industrial locomotives and all others weighing less than 25 tons, the total number of electric locomotives on the various railroad systems in the world is 1195, with a total weight of 87,270 tons. Of these, 537 with a total weight of 32,646 tons are in Europe, and 658 with a total weight of 54,624 tons are in North and South America. In all, 691 locomotives weighing 46,082 tons use direct current, and 504 weighing 41,188 tons use alternating current. In the United States alone there are more than 60,000 steam locomotives.

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Snow Surveying*

By J. E. CHURCH JR.†

On many drainage-basins in the West, the principal water-storage is in the form of snow, rather than in reservoirs. A survey of the depth and water-content of the snow on a given watershed is therefore the principal basis for an estimate of the run-off that will be available from that watershed for irrigation, power, or domestic uses.

Two general methods for estimating snow resources are used: measuring precipitation as it falls, and measuring the snow-cover on the ground. For several reasons, the first method is not satisfactory. For measuring the snow on the ground either the snow-stake, which is stationary and indicates the depth only, or the snow-sampler, which is portable and indicates both depth and water-content, may be used. The sampler is by far the more satisfactory of the two.

TAKING SAMPLE OF SNOW. THE SNOW IS AS DEEP AS THE LENGTH O F THE TUBE

A type of sampler that is recommended is shown in Plate I. It consists of a tube *A*, which may be of any convenient length. For measuring deep snow, however, it should be made in two or more sections, each from 4 to 10 ft. long, which are joined when required by screw-couplings, *B*. Extending through the length of the tube is a row of slots, *C*, through which the length of the sample or core may be observed. The depth of snow is indicated by a scale engraved on the tube near the row of slots. The outside diameter of the tubes is $1\frac{3}{4}$ in. The cutter, *D*, which is soldered to the tube, *A*, has an internal diameter of $1\frac{1}{2}$ in. for a distance of 0.12 in. from the bottom. At *E* the diameter is increased about 0.08 in., forming a narrow shoulder to prevent the sample from falling out when the instrument is withdrawn from the snow. The sample is removed by inverting the tube. Snow adhering to the inside of the tube may be dislodged with the cleaning-tool (Fig. 4). The water content of the sample is determined by weighing the tube and its core on a spring-balance, the dial of which is graduated to indicate depth of water instead of weight. For convenience in reading, the scale is hung on a staff (Fig. 6), which at other times may be used as a staff or ski-pole. A second wrench is desirable for unscrewing the sections of the sampler when they are stuck or frozen together. The weight of the equipment, including a sampler 21 ft. long, is about 25 lb. It can be carried even in rough country by two men. The sampler is made with a small diameter to facilitate driving it in deep firm snow. Comparative tests have shown that the difference in accuracy between a sampler of this diameter and one considerably larger is negligible. The accretion of snow through the slots while the sampler is being driven is so small as to be negligible when the samples are carefully taken.

The difficulties met in driving the sampler are two. First, the protuberance of the couplings forms an obstacle to driving. The slight bulge and the teeth upon the cutter make it possible by twisting the sampler to make a hole slightly larger than the diameter of the tube. There is, however, a slight accretion of snow through the slots. Second, when the temperature of the snow is below freezing and that of the air is above it, the snow will adhere to the orifice of the cutter after a depth of 10 or 12 ft. has been reached. The best way to avoid this is either to take samples when the temperature of the air is at or below freezing, or to take them late in the season when the temperature of the deep snow has risen to 32° F. Where both of these methods are impracticable, keeping the sampler in the shade as much as

*Abstract, Proceedings Second Pan-American Scientific Congress.

†University of Nevada, Reno, Nevada.

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possible helps considerably. If clogging cannot be avoided the sampler must be withdrawn from the hole when it becomes clogged, the sample weighed and the tube cleaned. The sampler should then be inserted into the same hole, driven until clogged and the operation repeated. Care should be taken to avoid scraping snow from the sides of the hole into the sampler.

A form such as is given below is a good one to use for recording:

LOCALITY, MOUNT ROSE. COURSE, CONTACT PASS

No.	Depth	Core	Water content	Density	Remarks
1.....	18.5	18.5	10.8	....	Centre of pass

The depth, core, and water content are recorded in inches and tenths. The length of the core is regarded as a check on the accuracy of the measurement. In case of doubt regarding the core, determine the density

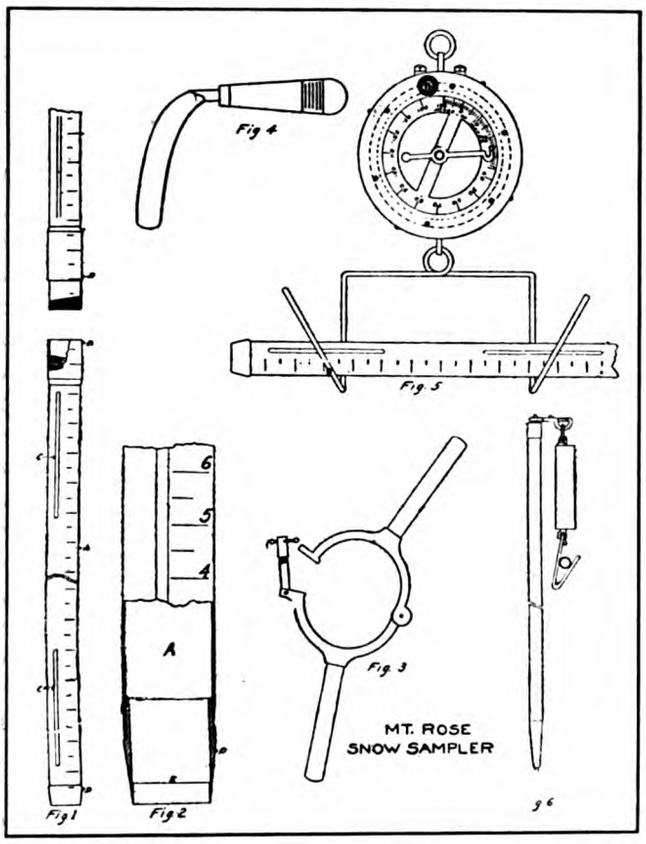

PLATE I. THE MOUNT ROSE SNOW-SAMPLER

(water content divided by depth) and compare it with adjacent measurements that are more reliable.

A sufficient number of measurements of the depth of snow on the ground made without determining the water content gives a fairly accurate idea of the seasonal percentage of precipitation. This is because the density of snow in a given district at a given time of the year and elevation varies between comparatively narrow limits.

In addition to measuring the snow on the ground, the evaporation from the snow while it is melting, the evaporation from water surfaces during storage, and the losses from absorption by the soil, should be determined. The evaporation-pans for measuring evaporation from snow are similar to those used for measuring the evaporation from water-surfaces. The normal amount of absorption can be obtained by subtracting the normal run-off and evaporation from the total normal precipitation. Before the soil has become thoroughly primed, the absorption is affected by the rate of run-off. However, after the run-off has become well-established, further loss from absorption is slight, irrespective of the rate of flow.

There are two general methods of snow surveying; by seasonal percentage and by areas.

In surveying by seasonal percentage the relation between the amount of snow at fixed points on the watershed and the normal snow-cover at the same points is determined. The normal run-off of the watershed is then multiplied by this percentage to determine the probable run-off. This method makes it unnecessary to consider absorption by the soil and evaporation, but variations in run-off caused by slow or rapid melting, air movements, and precipitation must be considered. To apply this method to a given watershed, the normal snow-cover and run-off must first have been determined. This method has been completely developed and applied only in the Lake Tahoe watershed. In using this method, it is important that the courses or points of measurement should be chosen so as to be representative of the variations in precipitation over the entire area. Such a survey should be made as nearly as possible at the end of the accumulation-period and before any considerable part of the snow has melted. On the Tahoe watershed, the survey of the areas at the lake level should be made before March 15, but the areas between elevation 7000 and elevation 9000 can be left as late as April 1.

Other methods of forecasting by the use of seasonal percentage are based on the depth of snow-cover, the accumulated snowfall, and the rise of a lake. The depth of snow-cover is determined for representative points on the watershed, just as in the method already described based on water content of the snow. Depth of snow-cover is not so good a basis for estimates as water content, but is better than either of the other methods. Variation in density is the principal objection to the use of the 'accumulated snowfall' method. An instance of the use of the rise of a lake is found at Lake Tahoe, where it has been found that the average rise of the lake after April 1 is slightly more than the average rise before April 1. This method has been used only to obtain results sufficiently accurate to safeguard property adjacent to the lake and to estimate the approximate amount of water available for power.

A relation can also be deduced between snow conditions at a single station and conditions over the entire watershed. Data secured at Tahoe City during four years of measurements gave variations not to exceed 11% as compared with measurements at four other stations symmetrically placed at points on the Tahoe watershed. Comparisons between the records of the Lake Tahoe, Carson River, and West Walker River watersheds indicate that a forecast based on measure-

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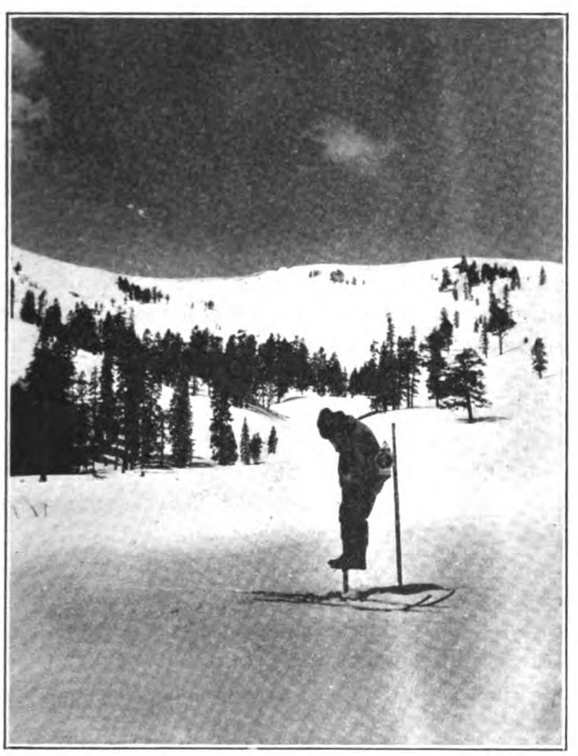
ments on one watershed can be applied to an adjacent and similarly situated watershed, with a maximum error of 15%.

While measurements of the snow-cover at the crest of the Sierra Nevada give a good indication of the run-off to be expected from the streams on the eastern slope of the mountains, the results are not so accurate for the streams on the western slope, which are longer and more affected by rains in the lowlands than are the streams on the eastern slope. Errors in estimation as great as 40% have been found, while for other streams the results have been fairly accurate. However, further investigation has shown that these larger errors are comparatively rare, and that they are caused by the variation in intensity of snowstorms passing from the western to the eastern slopes of the mountains. A supplementary system of courses part way down the western slope



DRIVING SAMPLER BY STANDING ON WRENCH

would furnish a reliable means of detecting and checking such errors.

In snow surveying by areas, the cubical water content of the snow on a given area is determined. Unlike surveying by seasonal percentage, this method necessitates taking absorption by the soil and evaporation into account, and this will prove troublesome until normal values for these factors have been determined. Several variations of the area-method have been tried, the most satisfactory being the surveying in typical parts of the watershed supplying Salt Lake City, and on the Lake Tahoe watershed.

In the survey of the Tahoe watershed, it was divided into east and west sections because of the great difference in precipitation between them. These sections were then divided along the 7000-ft. contour line because of the variation in precipitation and run-off with elevation. Where available, protected meadows or flats were chosen for courses, as being representative of the average snow-cover on the surrounding slopes. These courses were supplemented where necessary by others on lee and windward slopes, and in open and forested areas. About 25 courses were used. The area of the division of the watershed were determined by planimeter. In 1915 the method was used as shown in the tabulation below:

Water content of the snow-cover	Area, square miles		Water content, inches	
	West side	East side	West side	East side
Below 7000 ft....	79.8	48.1	15.3	4.8
Above 7000 ft....	87.0	89.1	33.8	18.7

Average water content of snow..... 19.2 in.
Total land area of watershed.....304.0 square miles
Area of lake surface.....192.7 square miles

The water in the snow on the land area of the watershed, if transferred without loss to the lake, would raise it as follows:

192.7 : 304 : : 19.2 in : rise of lake.
Rise of lake = 30.3 in. = 2.52 ft. = 310,786.56 acre-feet.

This estimate is made without reference to losses from evaporation from the snow, to absorption by the soil, and to evaporation from the surface of the lake while it is rising.

Evaporation from the snow varies greatly with elevation and consequent greater exposure to wind. For elevation 6000 ft., the evaporation in March and April is approximately 1.5 in. water content per month. For elevation 8000 ft. to elevation 9000 ft., the evaporation between March and June is approximately 2 in. water content per month.

Evaporation from Lake Tahoe based on measurements by the U. S. Geological Survey and U. S. Reclamation Service is as follows:

	Inches		Inches
December	1.30	April	1.85
January	1.11	May	2.44
February	0.86	June	3.32
March	1.24	July	4.42

The following computation is made to determine the absorption:

The actual mean rise of the lake before April 1 is 1.48 ft., the mean rise after April 1 is 1.67 ft. Since the rise before April 1 is caused almost entirely by precipitation on the surface of the lake, it is safe to assume a precipitation fully as great on the land area that drains into the lake. If there were no evaporation-loss, the absorption could be determined as follows:

304 : 192.7 : : run-off : 1.48 ft.
Run-off (not corrected for absorption) = 2.33 ft.
Normal actual run-off, 1.67 ft.
Absorption, 0.66 ft. or 28.3%.

However, since the water in the lake is evaporated more rapidly than the snow on the watershed, a correction should be applied to the lake-level to restore the balance. For this an approximate value of 3.5 in. or 0.29 ft. is proposed for the period preceding April 1, and the same or a slightly larger amount for the period

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after April 1. The normal mean rise of the lake before April 1, corrected for difference in evaporation, would then be 1.77 ft. and rise after April 1, 1.96 ft. The absorption would then be computed as follows:

	Feet
Run-off, corrected for difference in evaporation, but not corrected for absorption	2.79
Normal actual run-off (corrected for evaporation)	1.96
Absorption	0.83

The average estimate of the rise for 1915 is as follows:

Run-off lost by absorption	29.7%
Average water content of snow	19.2 in.
Evaporation of snow (in terms of water content)	4.13 in.
Estimated rise of lake, including losses by evaporation and absorption	21.24 in.
Evaporation-loss	7.61 in.
Absorption-loss (no deduction as ground appeared saturated)	...
Estimated net rise of lake	1.35 ft.
Actual rise	1.31 ft.
Error	3%
Estimated rise based on seasonal percentage	1.20 ft.

Snow surveying by areas requires twice as many courses and observations as snow surveying by seasonal percentage. The area-method is particularly applicable to watersheds where original data regarding run-off must be obtained from the snow-fields themselves, but even in such cases the method should be remodeled as soon as practicable on the basis of seasonal percentage.

The seasonal-percentage method requires the establishment of the normall snowfall in terms of water content. Until this normal can be established, the records for the year under consideration must be compared with those of a preceding year for which the precipitation and run-off are known.

For the Tahoe watershed an approximate normal was established in 1909 based on a 23-year record kept by the U. S. Weather Bureau of snowfall in adjacent parts of the Sierra Nevada and a 10-year record of the seasonal run-off into Lake Tahoe kept by the Truckee River General Electric Co. Since 1909, the seasons may be grouped into two groups of three, each including one year of heavy, one year of normal, and one year of light precipitation. The following tabulation illustrates the method of computing the normal snowfall:

	West side			East side
	Ward creek (7000 ft.)	Rubicon peak (8100 ft.)	Mt. Tallac (8000–9750 ft.)	Mt. Rose (9000–10,800 ft.)
1909-10	...	36.10	....	22.01
1910-11	...	72.95	....	44.31
1911-12	...	22.45	....	13.54
1912-13	17.81	30.20	27.17	14.51
1913-14	64.73	63.07	59.30	42.91
1914-15	43.17	35.72	32.88	39.78
Six-year average	41.90	43.00	39.78	26.80
Average west side for six years				42.70
Average entire watershed				34.76

In case records of accumulated snowfall are lacking, the seasonal percentage of any year can be based on the run-off.

For the six years 1909 to 1915, the variation between the actual rise of the lake and the corrected forecast was as follows: 1909-10, 5.7%; 1910-11, −1.0%; 1911-12, −1.9%; 1912-13, −10.5%; 1913-14, 3.8%; 1914-15, −5.9%.

Studies have been made of the Tahoe watershed and other Sierra Nevada records of the effect of omitting part of the density measurements, measuring depth only at these points. This investigation shows that density measurements may be omitted for 90% of the readings on any single course without affecting the results more than 2.7%. Where four separate stations are maintained, the average error for all will not exceed 1.4%. If the density measurements in any one course are used to represent the entire watershed, errors as great as 6.9% might be made. Finally if density measurements were omitted entirely, and only the depth of snow taken, the error might be as great as 17.2%. Taking density measurements at one point in ten and depth measurements only at the other nine will permit a reduction of one-fourth in the time and consequently the expense of making a snow survey.

The cost of making a snow survey depends upon the accessibility of the watershed and the number of courses required. On the Tahoe watershed, which has a total area of approximately 500 square miles, and which is accessible by water, a survey can be made by two men in 10 days at a maximum cost of $150, using seasonal percentages. This amount includes the cost of rainfall measurements during the spring and early summer. If the courses at Tahoe City are substituted for the high-level courses now used, the survey could be made for $25, including the measurement of rainfall as before. The results, of course, would not be so accurate. Surveys on watersheds in Nevada would probably cost about the same or a little more than at Lake Tahoe. On the larger watersheds of California, the cost would probably be about twice the cost at Lake Tahoe.

Before snow surveying can attain its highest efficiency, three things must be accomplished, as follows:

1. More accurate measurements should be made of the evaporation from snow-fields and lake-surfaces, and a careful investigation should be made of eccentricities in run-off resulting from variations in temperature and other weather conditions.

2. An intensive study should be made of the long streams of California and others similarly situated, in which the belt of maximum precipitation is considerably below the crest of the mountains. Not only should gaging-stations be placed at the spring snow-line in order to segregate, if possible, the measurement of flood-waters from the summer flow, but stations for snow surveying and the measurement of rain should be established near the line of maximum precipitation to supplement the measurements along the crest.

3. Finally, further surveys should be started in the watersheds along the axes of the mountain ranges in order to ascertain the extent to which the variation in seasonal precipitation in one basin can be applied to others, and thus to determine the minimum number of surveys required for an entire mountain system.

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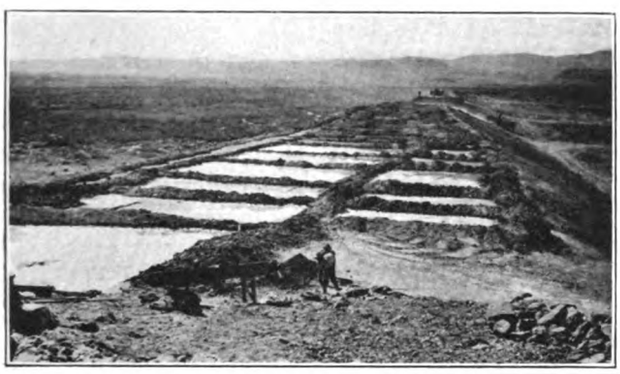
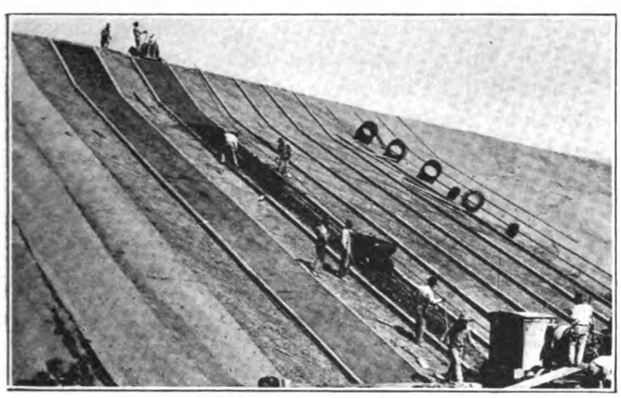
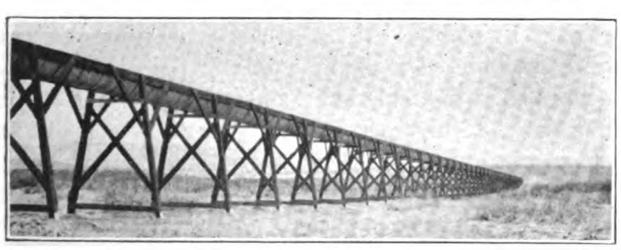
The Balmorhea Irrigation Project

By V. L. SULLIVAN

The Reeves County water improvement district of Balmorhea, Texas, has just completed an extensive addition to its irrigation system. The object of this work is to add to the water supply available from the former canal system, which was purchased by the district and which obtained its supply from springs in the foot-hills of the Davis mountains. A long reinforced concrete diversion-dam was constructed across Madero canyon together with flood-water head-gates and an inlet-canal 4½ miles long, which diverted the flood-water of this canyon into the creek that leads to the storage-reservoir. The inlet-canal has a capacity of approximately 1000 cu. ft. per second. The first two feet was excavated with fresno scrapers, and the remainder with a drag-line dredge. At the storage-dam, a trench 40 ft. wide at the top, 5 to 15 ft. at the bottom, and 10 to 20 ft. deep was excavated to a solid foundation of rock or clay. The trench was filled with water and with good earth material. Over this puddled trench the earth dam was built in 3-ft. layers. Each layer when completed was bordered and cross-bordered if necessary, and flooded with water. This water was allowed to stand for several days so that the moisture would saturate the entire layer. Before another layer was placed post-hole diggers were used to see that the first layer had been thoroughly saturated. This process of settling and compacting the material was continued to the top of the dam. The dam was 2500 ft. long and 47 ft. high. The slope on the up-stream side was 2½ to 1 and on the down-stream side 1½ to 1.







'PONDING' DURING CONSTRUCTION OF DAM. PLACING PAVEMENT ON DAM. CORRUGATED-IRON FLUME

The inner slope of the dam is protected from wave action by reinforced concrete paving. This is laid in slabs 6 ft. wide extending up the slope from a concrete toe-wall at the bottom of the dam. The slabs are 7 in. thick at the bottom and 4 in. at the top. Joints had 'steps' or 'off-sets' with felt between the slabs. The reinforcement, made of continuous heavy netting, passed through the slabs and joints diagonally at the off-set point of the joints just below the felt. The diagonal placing of the reinforcement was to allow for expansion and contraction without undue tension on the reinforcing material. The step in the joint also provides for the contraction of the concrete without leaving an opening through the joint for leakage. The foundation for the concrete paving was prepared by wetting the dam and tamping the surface with bars.

The outlet-canal is approximately 2½ miles long and empties into the main distributing canal of the old system. About half of this distance is in rock. There is one flume, 975 ft. long, made of Armco iron with concrete bulkheads at each end. The bents rest on concrete blocks. The bents, stringers, and other framework of the flume are made of creosoted timber.

The work was done under the direction of V. L. Sullivan, formerly territorial engineer for New Mexico. The total cost was $150,000.

Electrolytic action on reinforced concrete trolley-poles between Utica and Syracuse, New York, was investigated recently. Only 3 poles out of 1500 had developed defects, the trouble in each case being the result of leakage of the 600-volt trolley-current through the reinforcing-rods to the earth. This could be prevented by insulating the poles. In each case, warning of the failure was given by the gradual cracking of the concrete a considerable time before there was any danger of the pole itself failing.—'Mechanical World.'

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Street Improvements at Vallejo

During the past two years an extensive street-improvement programme has been followed at Vallejo, until it is now one of the best-paved cities in California. Part of this work has been handled by private contract, but most of it was done by public proceedings in two main districts, the Northern and the Central improvement districts.

Contract for the work in the Northern improvement district was awarded to the Worswick Construction Co. in August 1916, the following being the quantities and unit prices:

Item and quantity	Unit price
Excavation, 56,248 cu. yd.	$0.48
Sidewalks, sand-fill, and adobe trenching, 407 cu. yd.	1.15
Reinforced concrete retaining-wall, 70 cu. yd.	20.00
Concrete base for asphaltic concrete pavement, 754,715 sq. ft.	0.0792
Asphaltic concrete surface, 1 in. thick, 751,715 sq. ft.	0.0231
Asphaltic concrete surface, 2 in. thick, 2600 sq. ft.	0.04
Brick pavement on concrete base, 18,326 sq. ft.	0.26
Concrete sidewalks, 21,362 sq. ft.	0.115
Concrete curbs, 38,527 sq. ft.	0.40
Galvanized steel curb-armor, 1226 ft.	0.25
Reinforced concrete guard-rail, 730 ft.	1.50
Corrugated-iron culverts, 6 by 16 in., 140 ft.	1.38
Corrugated-iron culverts, 8 by 18 in., 1664 ft.	1.48
Corrugated-iron culverts, 8 by 24 in., 68 ft.	1.52
Corrugated-iron culverts, 8 in. diam., 20 ft.	0.90
Header-boards, 1792 ft.	0.30
House-lateral sewers, 4 in. diam., 2793 ft.	0.50
Main sewers, 6 in., 820 ft.	0.68
Cast-iron hand-holes for culverts, 16 by 16 in., 31 in all	11.10
Cast-iron hand-holes for culverts, 18 by 24 in., 2 in all	18.45
Lamp-holes, 2 in all	15.00
Wye-branches in main sewer, 4 by 6 in., 34 in all	1.10

The work in the Northern district included practically all the unimproved streets in that part of the city. The specifications provided that, when embankments were more than 9 in. high, they should be built in 9-in. layers and rolled with a roller weighing not less than 200 lb. per linear inch. Wetting and rolling of embankments was done until a firm subgrade was obtained. The subgrade in excavations was sprinkled and rolled with a roller of the same weight as that used on the embankment, and depressions filled with good material, sprinkled, and rolled again.

For the concrete, Golden Gate cement, sand from Rio Vista, and crushed rock from McNear's point were used. The cement fulfilled the standard tests. The sand was graded so that 100% passed an 8-mesh screen, at least 60% passed a 20-mesh screen, not more than 85% a 50-mesh screen, and not more than 15% an 80-mesh screen. The rock was crusher-run and not more than 5% passed a ¼-in. opening. For concrete work all the rock passed a 1½-in. opening. For foundations, retaining-walls, catch-basins, manholes, and the base for the asphaltic concrete pavement a 1 : 2½ : 5 mixture was used. For curbs, culvert-inverts, guard-rails, sidewalks, and the base for vitrified-brick pavement, a 1 : 2 : 4 mixture was used. In both cases the ratio between the cement and sand was fixed and the amount of rock was varied to produce a mixture with maximum density. A batch-mixer was specified, mixing by hand being allowed by special permission. The concrete base for asphaltic concrete pavement was 4 in. thick and was kept wet for three days and protected from traffic for seven days.

Sidewalks consisted of a base 3 in. thick of 1 : 2 : 4 concrete with a surface layer ½ in. thick of one part cement to one and one-half parts fine screened gravel. Where the subgrade was found to be adobe this was removed to a depth of 6 in. and the space filled with sand. Where the earth was loamy or sandy 2 in. was removed and replaced with sand.

In general, streets 60 ft. between property-lines had a pavement 32 ft. wide and streets 80 ft. wide had a pavement 40 ft. wide. For several blocks, where the transverse slope of the street was so great that grading in the ordinary way would necessitate an excessive amount of excavation, and also leave the houses on the upper side of the street at an inconvenient height above the street-grade, double roadways at different elevations were constructed. These roadways were 16 ft. wide, separated by a parking-strip and a retaining-wall, the parking-strip being on the natural slope of the soil. On the lower side of the upper roadway, a reinforced concrete guard-rail was placed with posts 8 ft. apart, capped with a rail 3 ft. 2 in. above the curb-grade.

The paint-coat for asphaltic concrete pavement was applied when the concrete base had become thoroughly dry and had been cleaned. The coat was composed of one part by volume of asphaltic cement to one part engine-distillate. On the first part of the work the coat was applied with stable and bamboo brooms, and on the latter part of the work by spraying a richer mixture with an oil-pump. Neither method was entirely satisfactory. The first method allowed the paint to penetrate the base and the asphalt in the paint returned to the surface only after 10 or 15 days. The second method did not distribute the paint with sufficient uniformity.

The asphaltic concrete wearing surface was composed of California asphalt with a penetration of 70 to 80°, limestone filler, Antioch and Marysville sand, and Natomas rock, proportioned according to the standard topeka specification. The deficiencies of mesh-composition of the Antioch sand were corrected by the addition of Marysville sand. The proportions used were one part Marysville sand to two to four parts Antioch sand. The addition of the Marysville sand increased the density of the mixture, thus holding the ¼-in. and ½-in. rock more

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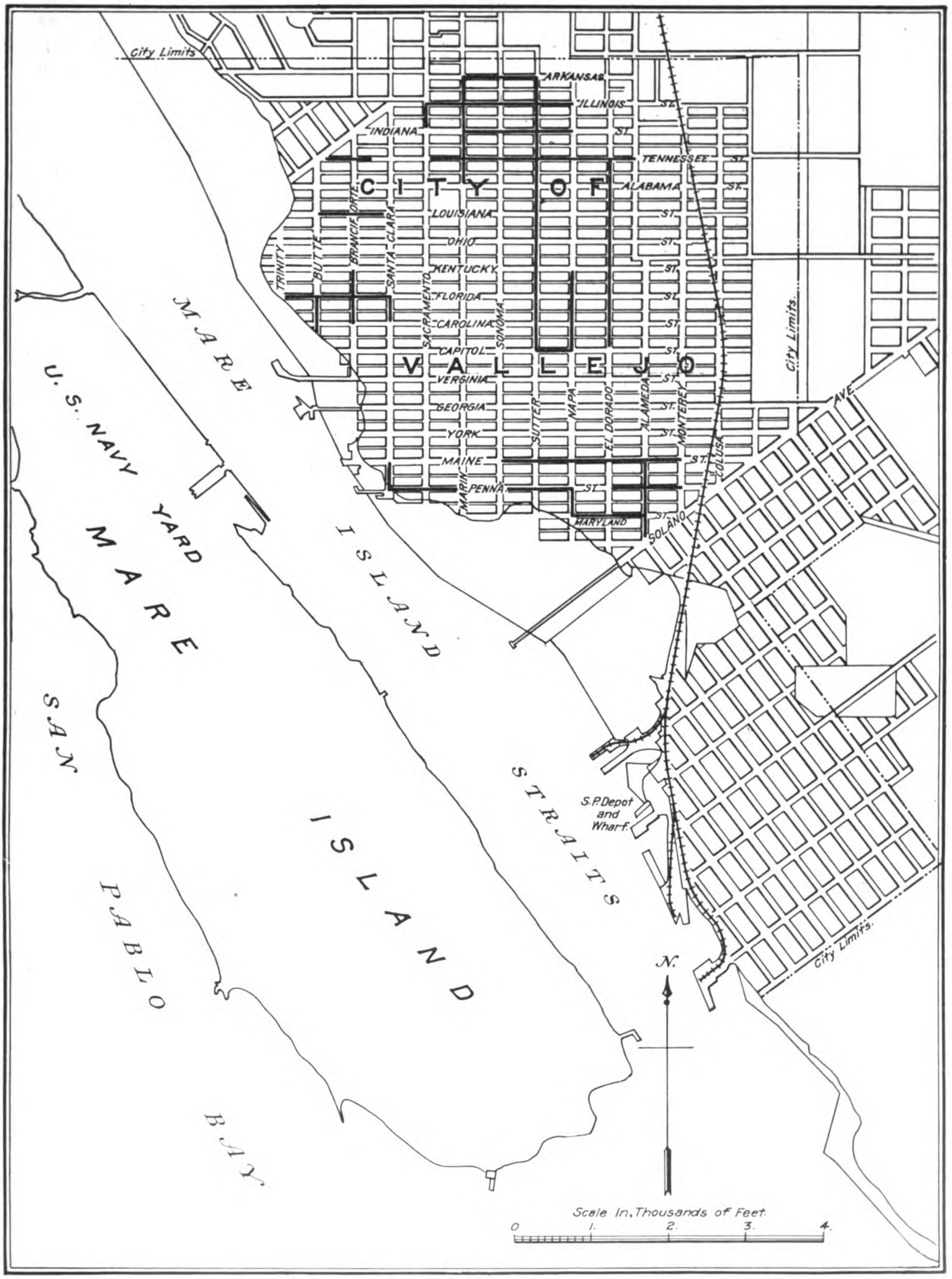

MAP OF VALLEJO SHOWING STREETS RECENTLY IMPROVED AND UNDER CONSTRUCTION

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firmly. The range in temperature at which the mixture was laid was small. After laying, the wearing surface was compressed by three rollers, weighing successively, 2½, 5, and 8 tons. The lightest roller gave a compression of 125 lb. and the heaviest, 210 lb. per linear inch.

Where the wearing surface was only 1 in. thick, it was impracticable to prevent the formation of small undulations from 6 in. to 2 ft. apart. The same crew and equipment working on adjacent streets under private contract, and laying a surface 1½ in. thick, obtained a surface without undulations. The undulations were most troublesome when the mixture was laid a little cooler than usual. The undulations in the concrete base did not coincide with the undulations in the wearing surface.

Brick pavement composed of No. 2 'hillside' brick was laid on some streets with heavy grades. A concrete base 2¼ in. thick composed of the following mixture was used: 1 part cement, 2 parts sand, and sufficient crushed rock or gravel to give a concrete of maximum density. After the base was laid, a bed of cement mortar ¼ in. was placed for the bricks. When the bricks were laid, they were tamped by hand, being too uneven to roll, and were grouted with a mixture composed of 1 part cement to 1½ parts sand. The pavement was then covered and kept damp for seven days.

The work in the Central improvement district was also awarded to the Worswick Construction Co. in September 1917, the unit prices being as follows:

Item and quantity	Unit price
Excavation, 17,951 cu. yd	$0.64
Sand-cushion for sidewalks, 85 cu. yd	2.00
Sand-cushion for pavement, 54,922 sq. ft	0.02
Concrete curbs, 18,789 sq. ft	0.50
Concrete base for bitulithic pavement, 243,983 sq. ft	0.075
Bitulithic wearing surface, 243,983 sq. ft	0.075
Plain concrete pavement, 54,922 sq. ft	0.15
Concrete sidewalks, 13,947 sq. ft	0.135
Surb-armor, 736 ft.	0.40
Reinforced concrete guard-rail, 570 ft	2.50
Corrugated-iron culverts, 12 gage, 832 ft	2.00
Corrugated-iron culverts, 16 gage, 286 ft	1.75
House lateral sewers, 4 in., 1944 ft	0.60
Main sewers, 6 in., 1675 ft	1.00
Main sewers, 8 in., 1430 ft	1.50
Manholes, 4 in all	90.00
Lampholes, 10 in all	25.00
Catch-basins, 10 in all	60.00
Expansion-joints, 5344 ft.	0.19
Wye-branches, 4 by 6 in., 70 in all	1.50
Wye-branches, 4 by 8 in., 34 in all	2.50
Plank sewer-foundation, 480 ft	0.35

Grading and sewer construction on this contract is now practically completed, and the paving will be finished during the coming spring. When completed, practically all the unimproved streets in this part of the city will have been improved. In particular, a low-grade improved highway will be provided between the main business part of the city and the Southern Pacific depot and wharves at South Vallejo. The streets that are now used for trucking between the two places have several steep grades.

The general character of the improvements in both the northern and central districts was the same, except that, while in the northern district topeka pavement was used on the light grades and brick pavement on the heavy ones, in the central district bitulithic pavement was used on the light grades and plain concrete pavement on the heavy ones. The specifications for sand were changed as follows: 100% to pass a 4-mesh screen, not less than 30% nor more than 90% a 20-mesh screen, not more than 30% a 50-mesh, and not more than 5% a 100-mesh screen. All rock whether for pavement-base or for other uses is to pass a 1½-in. opening. The concrete base for pavement is to be kept wet for five days instead of three. The mixtures for concrete are as follows: Concrete for foundations, retaining-walls, catch-basins, manholes, and concrete base for bitulithic pavement, 1:3:6 mixture. Concrete for curbs, culvert-inverts, guard-rails, and sidewalks, 1:2:4 mixture. Concrete for plain concrete pavement, 1:1½:3 mixture. The proportion of cement to total aggregate remains fixed, and the proportion between the sand and rock is varied to give the maximum density.

Bitulithic pavement 1½ in. thick is to be laid on a 4-in. concrete base on the lighter grades and level stretches. Plain concrete pavement 5 in. thick on a sand cushion 1 in. thick is to be laid on some of the steeper grades. Expansion joints with 'elastite' filler are to be placed 35 ft. apart.

The heaviest grade on which bitulithic pavement is to be placed is 10% and the heaviest grade for plain concrete pavement is 12%. The surface of the concrete pavement is not to be corrugated, but no difficulty is expected on account of slipping or skidding in wet weather since no trouble is experienced with concrete-paved streets now in service on steep grades. In particular, Georgia street, the main business street of the city, has a 9% grade a short distance from the business centre. This hill was paved several years ago with a sort of asphaltic concrete. A block or so south is an alley with the same grade that is paved for its entire length with concrete. Loaded teams go out of their way to travel on this alley, particularly in wet weather when the Georgia Street hill is practically impassable for heavy loads. In this connection, it is interesting to note that this and other concrete-paved alleys in the city are 'dished' so that the water flows to the centre of the alley in wet weather. This arrangement has been satisfactory.

T. D. Kilkenny, city engineer of Vallejo, is in general charge of the work. F. W. Seymour, formerly superintendent for the City Street Improvement Co. and the California Bitulithic Co., has been inspector of the pavement. E. D. Boivin and H. A. Harrold have been assistant engineers on the work. Mr. Harrold is now city engineer of Napa.

A ton of pure limestone would burn to about 1120 lb. of lime. The weight of the burned product is always more than this, both because of impurities in the limestone and because the combustion is not complete enough to drive off all the carbon dioxide.

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The Strength of Sewer-Pipe

Bulletin No. 47 of the Engineering Experiment Station of the Iowa State College of Agriculture and Mechanic Arts has recently been issued on 'The Supporting Strength of Sewer-Pipe in Ditches and Methods of Testing Sewer-Pipe in Laboratories to Determine Their Ordinary Supporting Strength,' by A. Marston, W. J. Schlick, and H. F. Clemmer. A series of experiments on the loads on pipes in ditches has been made at Ames, Iowa, by a sub-committee of Committee C-4 of the American Society for Testing Materials, and a theory deduced regarding these loads that may be summarized as follows:*

Any pipe in a ditch may be considered as made up of quadrants divided by two diameters at angles of 45° with the vertical. The two vertical quadrants, because of their position, carry only a negligible amount of the load. The foundation pressure is distributed over the bottom quadrants, the uniformity of distribution depending on the care of pipe-laying. The load on the pipe caused by or transmitted through the ditch-filling rests almost entirely on the top quadrant, with intensity somewhat greater at the centre than at the sides.

It has been proved by experiment and by careful study of pipe in ditches that the pipe in the ditch is so much more rigid than the ditch-filling at each side of the pipe, that, even with careful tamping, the pipe carries practically all of the vertical load at the level of the top of the pipe caused by or transmitted through the ditch-filling. The load may be said to 'arch over' between the pipe and the sides of the ditch, at least for all ditches that are common in pipe-sewer construction.†

The width of the ditch at the elevation of the ends of the top 90° quadrant is the width-factor that affects the load on the pipe. The ditch may widen indefinitely above this level without increasing the load on the pipe appreciably. Filling in such added width will be carried on the solid soil instead of on the pipe. This filling is shallower than the filling over the pipe and settles less. Frictional resistance develops along vertical lines. This helps to carry part of the weight of the rest of the ditch-filling, just as in the case of vertical-sided ditches. This same width at the ends of the top quadrant, rather than the diameter of the pipe itself, is what determines the total load on the pipe. For example, in one experiment, two pipes of different diameters were tried successively in the same ditch, and were found to be subjected to the same load. Sewer-pipe has been found cracked in the wide parts and sound in the narrow parts of the same ditch. Pipe from the same factory has cracked in wide ditches and remained sound in narrow ditches in the same drainage districts.

The ditch-filling above the top of the pipe settles in relation to the sides of the ditch, thereby developing frictional resistances, which carry part of the weight

*See Bulletin No. 31, Iowa Engineering Experiment Station.

†In ditches that are wide as compared with the diameter of the pipe the filling at the sides will carry an appreciable part of the load, but it is safer not to count on such precarious additional support.

TABLE I. SAFE VALUES OF C FOR USE IN FORMULA $W = CwB^2$

Ratio H/B = Height of fill above top of pipe to breadth of ditch a little below the top of the pipe	SAFE WORKING VALUES OF "C"				
	Minimum possible without cohesion. These values give the loads generally imposed by granular filling materials before tamping or settling	Maximum for Ordinary Sand. Use these values as safe for all ordinary cases of sand filling	Completely Saturated Top Soil	Ordinary Maximum for Clay (Thoroughly Wet). Use these values as safe for all ordinary cases of clay filling	Extreme Maximum for Clay (Completely Saturated). Use these values only for extremely unfavorable conditions
0.5	0.455	0.461	0.464	0.469	0.474
1.0	0.830	0.852	0.864	0.881	0.898
1.5	1.140	1.183	1.208	1.242	1.278
2.0	1.395	1.464	1.504	1.560	1.618
2.5	1.606	1.702	1.764	1.838	1.923
3.0	1.780	1.904	1.978	2.083	2.196
3.5	1.923	2.075	2.167	2.298	2.441
4.0	2.041	2.221	2.329	2.487	2.660
4.5	2.136	2.344	2.469	2.650	2.856
5.0	2.219	2.448	2.590	2.798	3.032
5.5	2.286	2.537	2.693	2.926	3.190
6.0	2.340	2.612	2.782	3.038	3.331
6.5	2.386	2.675	2.859	3.137	3.458
7.0	2.423	2.729	2.925	3.223	3.571
7.5	2.454	2.775	2.982	3.299	3.673
8.0	2.479	2.814	3.031	3.366	3.764
8.5	2.500	2.847	3.073	3.424	3.845
9.0	2.518	2.875	3.109	3.476	3.918
9.5	2.532	2.898	3.141	3.521	3.983
10.0	2.543	2.918	3.167	3.560	4.042
11.0	2.561	2.950	3.210	3.626	4.141
12.0	2.573	2.972	3.242	3.676	4.221
13.0	2.581	2.989	3.266	3.715	4.285
14.0	2.587	3.000	3.283	3.745	4.336
15.0	2.591	3.009	3.296	3.768	4.378
Very great	2.599	3.030	3.333	3.846	4.545

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of the ditch-filling. The total weight of the ditch-filling at the time when the maximum load on the pipe occurs consists of two parts, one carried by the pipe and the other by the frictional resistances. At other times than those of maximum loads, part of the total weight is carried to the sides of the ditch by cohesion, thus lightening the load on the pipe. In the long-time tests at Ames, Iowa, the loads between maxima sometimes became as low as 65% of the maximum, but the average was about 75%. Maximum loads may recur from time to time, with changes in the condition of ditch-filling, especially as to degree of saturation.

The following formula has been deduced for the loads on pipes in ditches, where the trench is hollowed to conform to the bottom quadrant of the circumference of the pipe:

$$W = Cwb^2$$

where W = load on pipe in ditch in pounds per linear foot.

C = coefficient (see Table I).

w = weight of ditch-filling material, in pounds per cubic foot.

B = breadth of ditch a little below the top of pipe, in feet.

The loads first imposed by re-filling a pipe-sewer trench are not as great as those indicated in Table I. Under favorable conditions, individual stretches of pipe may never carry loads as great as these, but there is always a chance of the occurrence of such loads. The maximum load from ditch-filling on a sewer-pipe usually occurs at the time of the first thorough saturation of the material. In one particular test at Ames of a 10-ft. length of 24-in. pipe under 21 ft. of a clay re-fill, the maximum load occurred the spring following the re-filling of the trench. The load was then 3765 lb. per linear foot. The following spring, a second maximum of 3150 lb. per linear foot was recorded.

A factor of safety of $1\frac{1}{2}$ is recommended for use in design. Table II shows the supporting strengths that should be specified for the given conditions using this factor. 'Ordinary' pipe-laying is pipe-laying in accordance with customary good practice in tile-drain construction, where the pipe is well-bedded on soil for 60 to 90° of the circumference. 'First-class' pipe-laying is pipe-laying in accordance with the best practice in pipe-sewer construction, where the entire under-side of the pipe is thoroughly bedded on soil, and the entire pipe is surrounded by well-compacted soil, placed under the direction of an inspector that is constantly present on the work. The tests at Ames have shown that concrete cradles can be constructed at a reasonable cost, which will increase the supporting strength of sewer-pipe and drain-tile 100% or more above the ordinary supporting strengths. However, a large amount of experimental investigation is still needed to determine the best designs for such cradles. This work is now being done at Ames as rapidly as resources will permit.

Attention is called to 'impermissible' pipe-laying methods, namely, those in which the bottom of the ditch is not suitably rounded to fit the under-side of the pipe, or in which hub-holes are not properly excavated, or in which the re-filling material is not placed to fill all around the pipe, or in which other defects of similar general character are allowed. Such methods reduce the supporting strength of pipe and tile considerably, and should not be allowed.

Tests were also made to determine the supporting strength of pipe bedded and surrounded entirely by tamped gravel. These tests indicated a supporting strength somewhat higher than for 'first-class' pipe-laying and about 25% more than for 'ordinary' pipe-laying.

For making tests of sewer-pipe and drain-tile, three methods are recommended, namely, in 'sand' bearings, in 'two-point' bearings, and in 'three-point' bearings. When 'sand' bearings are used the specimens shall be carefully bedded in sand above and below, for the full length of the pipe including the hubs, for one-fourth of the circumference of the barrel of the pipe, measured on the middle line of the wall, bedding the hub to the same level as the barrel. The depth of bedding above and below the barrel of the pipe at the thinnest points shall be one-half the radius of the middle line of the wall.

TABLE II. SUPPORTING STRENGTHS OF SEWER PIPE

Strengths in Pounds per Linear Foot

Height of Fill Above Top of Pipe Ft.	BREADTH OF DITCH A LITTLE BELOW TOP OF PIPE																			
	1 Ft.				2 Ft.				3 Ft.				4 Ft.				5 Ft.			
	PIPE LAYING METHOD																			
	Ordinary		First Class		Ordinary		First Class		Ordinary		First Class		Ordinary		First Class		Ordinary		First Class	
	DITCH FILLING MATERIAL																			
	Sand	Clay	Sand	Clay	Sand	Clay	Sand	Clay	Sand	Clay	Sand	Clay	Sand	Clay	Sand	Clay	Sand	Clay	Sand	Clay
2	265	280	220	235	615	635	510	530	970	990	805	825	1330	1350	1105	1125	1690	1710	1405	1425
4	400	450	335	375	1055	1125	880	935	1745	1825	1455	1520	2455	2535	2015	2115	3165	3250	2635	2710
6	470	545	390	455	1370	1500	1140	1250	2370	2525	1975	2105	3405	3575	2840	2980	4460	4640	3715	3865
8	505	605	420	505	1600	1790	1335	1490	2875	3115	2395	2595	4215	4495	3515	3745	5595	5890	4660	4910
10	525	640	440	535	1765	2015	1470	1680	3275	3610	2730	3010	4900	5295	4085	4410	6590	7020	5490	5850
12	535	660	445	550	1880	2185	1565	1825	3600	4030	3000	3355	5485	6000	4570	5000	7460	8035	6220	6695
14	540	675	450	560	1965	2320	1635	1935	3855	4380	3215	3650	5975	6620	4980	5515	8225	8950	6855	7460
16	545	680	455	565	2025	2425	1690	2020	4065	4675	3385	3895	6395	7165	5330	5970	8890	9775	7410	8145
18	545	685	455	570	2070	2505	1725	2085	4230	4920	3525	4100	6750	7630	5625	6360	9480	10520	7900	8770
20	545	690	455	575	2100	2565	1750	2135	4365	5130	3640	4275	7050	8060	5875	6715	9995	11190	8330	9325
22	545	690	455	575	2125	2610	1770	2175	4470	5305	3725	4420	7305	8425	6090	7020	10445	11795	8705	9830
24	545	690	455	575	2140	2645	1785	2205	4560	5455	3800	4545	7525	8750	6270	7290	10840	12340	9035	10285
26	545	690	455	575	2150	2675	1795	2230	4630	5575	3855	4645	7705	9035	6420	7530	11185	12830	9325	10690
28	545	690	455	575	2160	2695	1800	2245	4685	5680	3905	4735	7860	9280	6550	7735	11490	13270	9575	11060
30	545	690	455	575	2165	2715	1805	2260	4725	5765	3940	4805	7990	9500	6660	7920	11755	13670	9795	11395
Very great	545	690	455	575	2180	2770	1820	2310	4910	6230	4090	5190	8725	11075	7270	9230	13635	17305	11365	14425

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Tests with 'sand' bearings give directly, without any multiplication factor, the strength that would be developed by the same quality of pipe laid in ditches with the 'ordinary' pipe-laying method.

'Two-point' bearings are composed of upper and lower metallic bearings one inch wide and of sufficient length to load the full length of the barrel of the pipe, excluding the hub. The ultimate strengths obtained in 'two-point' tests should be multiplied by 10/7 to give the ordinary supporting strength.

Where 'three-point' bearings are used, the lower bearings shall consist of two wooden strips with vertical sides, each strip having its interior top-corner rounded to a radius of approximately ½ in. The strips shall be straight and shall be fastened securely to a rigid block with their interior vertical sides 1 in. apart. The upper bearing shall be a straight wooden block. All bearings shall extend the full length of the barrel of the pipe, excluding the hub. The ultimate strengths obtained in 'three-point' tests should be multiplied by 10/7 to obtain the ordinary supporting strength.

In computing the ordinary supporting strength of pipe per unit of length, the net inside length of the pipe from the bottom of the hub-socket to the extremity of the spigot-end should be used as a divisor. For calculating the modulus of rupture of sewer-pipe from the ordinary supporting strength, the formulas already adopted for drain-tile by the American Society for Testing Materials should be used, as follows:

$$M = 0.20r\frac{W}{12}$$

and $$F = \frac{6M}{t^2}$$

where M = maximum bending moment in the pipe-wall of the barrel of the pipe, in pound-inches per inch of length.

r = radius of the middle line of the pipe-wall of the barrel of the pipe, in inches.

W = the ordinary supporting strength of the pipe, calculated as described in the preceding paragraphs, in pounds per linear foot of pipe.

F = modulus of rupture of the pipe in pounds per square inch.

t = average thickness of the pipe-wall of the barrel of the pipe in inches at either the top or the bottom, the lesser value being used.

In computing M, for 'sand' bearings add ⅝ of the weight of the pipe per linear foot to W, provided such addition exceeds 5% of W. For 'two-point' or 'three-point' bearings add ¾ of the weight of the pipe.

A durable black varnish for cast-iron and forgings can be made of ½ lb. lampblack, ½ lb. resin, 1 lb. asphaltum, 1 quart turpentine spirits, and a small quantity linseed oil. The lampblack is first mixed with the linseed oil, no more oil being used than necessary for this purpose. The other ingredients are then added.—'Mechanical World.'

OIL-MIXED CEMENT-CONCRETE

Bulletin No. 230 of the U. S. Department of Agriculture contains the results of investigations recently made by the U. S. Office of Public Roads and Rural Engineering on the addition of oil to cement-concrete to make it waterproof. The oil used should be a fluid petroleum product with no admixture of animal or vegetal oils. It should not have a gravity lower than 17° Baumé. The flash-point should not be less than 150° C. by the closed-cup method. When 240 cc. of the oil is heated in an Engler viscosimeter to 50° C., and maintained at that temperature for at least three minutes, the first 100 cc. that flows out should show a specific viscosity of not less than 15 nor more than 30. When one part of the oil is shaken with two parts of hundredth normal caustic soda, there shall be no emulsification, and upon allowing the mixture to remain quiet, the two components shall separate rapidly in distinct layers. The quantity of oil should not exceed 10% by weight of the quantity of cement used, and the best results are obtained with 5% of oil. When not more than 10% of oil is used, the tensile strength of the concrete is not reduced, the compressive strength is decreased slightly, the time of set is about twice that of plain concrete, but the increase of strength is nearly as rapid as for plain concrete. The use of oil does not make the concrete impervious to heavy water-pressures, but does make it practically impervious for small pressure. The time of mixing when oil is used should be practically double the ordinary time. For this reason, a batch-mixer is preferred.

BLOWING DUST FROM MACADAM

In preparing macadam roads for the application of tar or oil, it is generally desirable to remove all dust from the top of the road in order to permit the bituminous material to penetrate the stone. If a portable air-compressor is available the dust can be blown off the road. This is the best way, for it cleans the upper interstices, while brooming only packs the dust into them. One plan is to attach to the end of the air-hose a T-shaped set of pipes formed of a tee and three pipes, a row of small holes being drilled in line in the two pipes that are fastened in the opposite openings of the tee. This set of pipes is held in the hand or may be fastened under the wagon carrying the air-compressor so as to come an inch or two above the road-surface. The air-jets should make a slight angle with the vertical blowing the dirt in the direction in which the wagon is moving.—'Municipal Journal.'

Cement has been used to protect an 8-in. oil pipe-line laid by the Standard Oil Co. of Louisiana, near Shreveport. The line crosses about 80 miles of marshy country. The cement coating is about 1½ in. thick and is used to protect the line against chemical action from the soil or from the water.

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Highway Construction

The final report of the Committee on 'Materials for Road Construction and on Standards for Their Testing and Use' of the American Society of Civil Engineers was presented at the annual meeting of the Society on January 16. The committee was composed of W. W. Crosby, chairman, H. K. Bishop, A. H. Blanchard, A. W. Dean, N. P. Lewis, C. J. Tilden, and G. W. Tillson. Some of the more important recommendations of the committee are as follows:

The maximum grades for various surfacing materials should be as follows:

Kind of roadway		Maximum grade, %
Asphalt block		8
Bituminous surfaces		6
Bituminous concrete		8
Bituminous macadam		8
Brick	cement filler	6
	bituminous filler	12
	'hillside' block	15
Broken stone		12
Cement-concrete		8
Gravel		12
Sheet asphalt		5
Stone block	cement filler	9
	bituminous filler	15
Wood block		4

The minimum grades allowable will depend on such local conditions as climate, type of construction, character and amount of traffic, conditions of underlying and adjacent soil, and such other circumstances as affect drainage. Except for roadways on fills, where the outside edges of the surfaces of the shoulders are at least 2 ft. above the level of the adjacent ground or water-level, or except in cases where the roadway is laid over sand of such a character that it never becomes water-logged, a longitudinal grade for the roadway of less than 0.5% should not be used. On streets where the smoothness and evenness of the roadway surface may be confidently expected to be the greatest, and where conformity to the proposed elevations of surface is more carefully sought and easier to obtain, a minimum grade of as low as 0.25% has sometimes given satisfactory results. A minimum of 0.5%, however, would be better as an established standard.

The width of the roadway to be built will be determined largely by local circumstances, but, in view of the recent, constant, and rapid increase of traffic on highways, both in number of vehicles and in size of loads, it will be in the interest of economy for designs of highways to be made with proper consideration of further increase. Where motor traffic forms a considerable proportion of the total traffic likely to use a highway, the unit width of traffic lines to be considered is 9 or 10 ft., instead of 7 or 8 ft., as heretofore, because of greater clearance required for the safe passing of the units of such traffic.

The thickness of pavement should be between the following limits:

Kind of roadway		Thickness of artificial foundation* (ordinary), inches	Thickness of sand cushion or binder course, inches	Thickness of wearing course, inches
Asphalt block		5 to 8	.....	2 to 3½
Bituminous surfaces		4 to 8	.....	¼ to ½
Bituminous concrete		3 to 8	.....	1½ to 3
Bituminous macadam		3 to 8	.....	2 to 3
Brick		4 to 8	¾ to 1½	3 to 4
Broken stone		3 to 8	.....	2 to 3
Cement-concrete	One course	.....	.....	5 to 8
	Two course	4 to 8	.....	2
Gravel		4 to 8	.....	2 to 4
Sheet asphalt		5 to 8	1 to 1½	1½ to 2
Stone block		5 to 12	1 to 2	2½ to 5
Wood block		5 to 8	0 to ½	3½ to 4

*Not including extraordinary provisions such as 'V-drains' or 'sub-base' courses.

The amount of 'crown' to the foot should be as follows:

Kind of roadway	Maximum, inch	Minimum, inch
Asphalt block	¼	⅛
Bituminous surfaces	½	¼
Bituminous concrete	½	¼
Bituminous macadam	½	¼
Brick pavements	⅜	⅛
Broken stone	¾	½
Cement-concrete	⅜	¼
Gravel	1	½
Sheet asphalt	¼	⅛
Stone block	½	¼
Wood block	¼	⅛

Where expansion-joints extending across the roadway are used, a bituminous filler is recommended. 'Armored' joints should not be used, since the minimum interruption to the homogeneity of the surface is desirable.

For a newly-completed pavement, variations from an exact surface may be allowed as follows: From a template 8 ft., ⅛ in. variation for asphalt-block, bituminous-concrete, brick, cement-concrete, sheet-asphalt, and wood-block pavements, and ¼ in. for broken-stone roads, and bituminous-macadam and stone-block pavements.

Bituminous pavement should not be laid between the tracks or between the rails of street-car tracks. Where the rails are in the centre of the street or roadway, stone blocks or brick should be laid for a width of at least 18 in. adjacent to the rails. When the track is at the side of the road, and the railroad area does not form a part of the roadway proper, loose broken stone or gravel may be substituted for the stone blocks or brick.

For bituminous-concrete pavement having a mineral aggregate composed of one product of a screening or crushing plant, broken-stone aggregate is recommended instead of gravel whenever possible because of the better

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bond obtained when stone is used. Best results are obtained when the aggregate is heated to between 150 and 250° F. The temperature recommended for asphaltic cement is 275 to 350° F., while if refined tar is used, this should be heated to between 200 and 275°F. The bituminous-concrete mixture should contain from 5 to 8% by weight of bitumen. The mixture delivered for laying should have a temperature of not less than 150° F. A thickness, after rolling, of 2 in. of bituminous concrete has been found to be economical and efficacious. A tandem roller weighing between 10 and 12 tons should be used. The seal-coat should consist of ½ to 1 gal. of bituminous cement per square yard of surface. This should be distributed uniformly, preferably by a hand-drawn distributor followed by a squeegee. The bituminous cement should be covered with dry stone chips, and then rolled. Pavements of this type should not be laid when the air temperature is lower than 50° Fahrenheit.

For bituminous-concrete pavements laid in accordance with the topeka specification, and for the various patented pavements of this type, the same general rules may be followed.

For bituminous-macadam pavements, the quantity of bituminous material should be only enough to penetrate through the upper course. This quantity varies with the hardness and the size of stone used, but will seldom exceed one gallon per square yard of surface. The stone should be dry and clean, the air temperature should not be less than 50° F., and the bituminous material should be applied at a temperature that will allow it to flow freely. The covering material used should preferably consist of the crusher product retained on a ¾-in. screen and passing through a ¼-in. screen. Finer material may be used if a slippery surface is not objectionable, but material passing through a 10-mesh sieve should be avoided.

For bituminous-surface treatment of broken stone, gravel, shell, or slag roads, either refined tar, cut-back asphalt, or asphaltic oil may be used. Material that is of such a consistence that it can be applied at a temperature of 125° F. is preferabe to heavier material. It should be applied at a rate of not more than ¼ gal. per square yard at a time, and not more than ½ gal. per square yard in all. For additional surface treatment to roads already bituminous, heavier material in small quantities should be used. The road-surface to be treated should be dry and free from depressions or dust. The bituminous material should be applied with a pressure-distributor, at a pressure of not less than 20 lb. nor more than 75 lb. per square inch. The material should be applied only after the road has been compacted thoroughly by traffic or by rolling. After the bituminous material has been applied, it should be covered with tough grit, preferably that passing a ⅝-in. and retained on a ⅜-in. screen. Rolling with a steam-roller after the grit has been applied is advisable, although not necessary.

For broken-stone roads, if the thickness of the pavement after rolling is to be 6 in., the stone should be such as will pass a 3-in. opening. Wher the pavement is to be 7 in. or more, 3½-in. stone may be used. Each course of the pavement should be rolled with a roller weighing between 10 and 15 tons. In specifications for the stone, the use of the standard form prepared by the American Society for Testing Materials is recommended, as follows:

"Passing .. in. screen (having smallest holes selected), from .. to ..%.

"Passing .. in. screen (having next to largest holes selected), from .. to ..%.

"Passing .. in. screen (having largest holes selected), from .. to ..%."

The thickness of concrete pavement at the centre may be diminished at the sides of the pavement. Not more than 5% of the sand used should pass a 100-mesh sieve, and not more than 3% a 200-mesh sieve. Coarse aggregate should pass a 2-in. opening, and be retained by a ¼-in. opening. Mixtures based on mechanical analyses of the aggregates are far better than arbitrary mixtures containing an assumed number of parts of fine and coarse aggregate to one part of cement. The time and money spent on such mechanical analyses is well-invested, even on a small job. The subgrade should be sprinkled just before the concrete is deposited. Vertical joints extending across the pavement should be placed whenever the work of depositing concrete is stopped for more than 30 minutes.

Sand-clay roads should be constructed as follows: The sand content should be from 70 to 80% at least. The sand used in sand-clay mixtures should preferably be composed of hard angular particles, at least 30% of which should be retained on a 50-mesh sieve. The clay content should vary from 10 to 20% and under no circumstances should be allowed to exceed 30%. The clay, when placed on the roadway, should not contain lumps larger than 3 in. diam. For natural sand-clay roads, the top-soil should be spread on a flat sub-grade to a depth of 10 or 12 in. at the centre and 5 or 6 in. at the sides. After the surfacing material has been laid, the ditches should be constructed, and the material obtained therefrom should be used in constructing shoulders. It is advisable to plow and then harrow the surfacing material, as a more homogeneous layer is secured thereby. The surfacing material should be compacted with a 'sheep-foot' roller, or else by the hoofs of animals and the wheels of vehicles going over the roadway. For successful results, thorough puddling is necessary, and this can practically be secured only by rains during the period of the work. After each rain during this time the surface of the roadway should be immediately re-shaped and crowned. When completed, the compacted roadway should have a depth of from 7 to 8 in. at the centre and 3½ to 4 in. at the edges, and have a crown of about ½ in. per foot. For sand-clay roads on clay sub-soil the roadbed should be graded level, and the parts to be constructed of sand-clay should be excavated to a sufficient depth so that the earth removed and placed on the shoulder of the road will give the right slope to the ditches. The depth of excavation should be from 1½ to 3 in., depending on the width of the road between ditches. The clay soil should

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then be plowed to a depth of 2 or 3 in., after which about 4 in. of sand should be spread evenly over the surface and thoroughly 'worked in' with a disk-harrow. Then 4 in. more of sand should be added and harrowed. During a rain, the sand-clay mixture should be harrowed thoroughly, and after the rain the roadway should be dragged into shape. For sand-clay roads on sand sub-soil a layer of clay from 2 to 4 inches thick should be spread evenly over the roadway after it has been graded level. A layer of clean sand should then be spread over the clay, and the roadway harrowed thoroughly. The roadway should be shaped with a drag, and during a rain it should be again harrowed. The roadway should be shaped finally with a grading-machine or a drag.

For gravel roads, the specifications adopted by the American Society of Municipal Improvements in 1916 are recommended, as follows:

"Two mixtures of gravel, sand, and clay shall be used, hereinafter designated in these specifications as No. 1 product (for top course) and No. 2 product (for middle and bottom courses).

"No. 1 product shall consist of a mixture of gravel, sand, and clay, with the proportions of the various sizes as follows: All to pass a 1½-in. screen and to have at least 60 and not more than 75% retained on a ¼-in. screen; at least 25 and not more than 75% of the total coarse aggregate (material over ¼ inch in size) to be retained on a ¾-in. screen; at least 65 and not more than 85% of the total fine aggregate (material under ¼ inch in size) to be retained on a 200-mesh sieve.

"No. 2 product shall consist of a mixture of gravel, sand, and clay, with the proportions of the various sizes as follows: All to pass a 2½-in. screen and to have at least 60 and not more than 75% retained on a ¼-in. screen; at least 25 and not more than 75% of the total coarse aggregate to be retained on a 1-in. screen; at least 65 and not more than 85% of the total fine aggregate to be retained on a 200-mesh sieve."

Stone blocks for pavement should be from 8 to 12 in. long, 3½ to 4½ in. wide, and 4¾ to 5½ in. deep. For light-traffic streets, this depth may be reduced. Attention is also called to 'durax' blocks, which have been used to a considerable extent in England and have recently been tried in this country. These blocks are approximately cubical, from 2½ to 4 in. each way, but they should not be exactly cubical, as they are laid in arcs of comparatively small radii. By laying the blocks in this way the lines of traffic are not parallel to any of the joints. Pavements are also laid with blocks that have been split from old blocks. As these new blocks are relatively small they can be dressed to a fairly true surface. In some cases, a greater area has been paved than with the original blocks. Stone-block pavement should always be laid on a concrete foundation, with either a sand or a mortar cushion. A bituminous filler is better than cement grout both because of the greater convenience when taking up part of the pavement becomes necessary, and because the pavement can be thrown open to traffic in a shorter time than when cement grout is used.

Brick pavement should be laid in straight courses at right angles to the axis of the roadway, except at intersections, where diagonal courses will be advantageous. The cushion to be placed on the concrete foundation may be of sand 1 in. thick, or a cushion composed of sand or stone chips and bituminous cement ½ in. thick may be used, provided the surface of the concrete is smooth and regular. A cushion-course of cement mortar is also used, but this gives a monolithic structure less capable of absorbing shock than a sand or a bituminous cushion. If the variation in depth of the bricks does not exceed ⅛ in., the thickness of the sand cushion may be reduced to ¾ inch.

For wood-block pavement, southern yellow pine, Douglas fir, tamarack, Norway pine, hemlock, and black gum timber may be used, the first two being the most common. The number of annual rings in the 1-in. space that begins 2 in. from the pith of the block should not be less than 6, measured radially, provided, however, that blocks containing between 5 and 6 rings in this inch may be accepted if they contain 33⅓%, or more, of summer-wood. If the block does not contain the pith, the 1-in. space to be used in this determination shall begin 1 in. away from the ring that is nearest to the heart of the block. The blocks should contain at least 70% of heart-wood, and no single block should contain less than 50% of heart-wood. The length of the blocks should be from 5 to 10 in., preferably twice the depth. The depth should be 4 in. on heavy-traffic streets, 3½ in. on streets with moderate traffic, and 3 in. on light-traffic streets. The width should be from 3 to 4 in., but should be uniform for any one city block. A variation of $\frac{1}{16}$ in. should be allowed in the depth and ⅛ in. for the width. The difference between the depth and the width should not be less than ¼ in. Coal-tar creosote-oil is the best preservative. At least 16 lb. of water-free oil should be used per cubic foot of wood. In all cases the sap-wood should be penetrated completely. Blocks should be laid as soon as possible after treatment. If they cannot be laid immediatly, they should be kept moist until laid. The wood must be swelled to its maximum size before being laid. The blocks should always be laid on a concrete foundation. It is better to take pains to have this foundation true and regular and to lay the blocks directly upon it, than to lay them on a sand or mortar cushion. A sand filler is best for heavy-traffic streets, but a bituminous filler may be used for light-traffic streets, provided that the pavement is covered with a thin layer of fine sand, which should be allowed to remain for a week or two after the street has been opened to traffic. Cement grout should not be used as a filler. Proper care in laying will prevent 'bleeding' of the pavement, but if 'bleeding' should occur, it can be remedied with one or two applications of fine sand.

The report also contains a list of definitions of terms used in highway work and three appendices, on 'Forms of Record for Data Concerning the Use of Highway Materials,' 'Tests of Bituminous Materials,' and 'Tests of Non-Bituminous Materials.'

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extension of kiln-drying in fields where air-drying is now practised would result in a saving of at least $17,000,000 per year. The author of the present volume is in charge of kiln-drying experiments for the U. S. Forest Service. After a discussion of the structure and properties of wood, the special problems of kiln-drying are considered. The theoretical analysis of these problems is supplemented by illustrations from practical experience. The design and construction of dry-kilns and the various methods of drying, including the use of superheated steam and of a vacuum, are considered. Recommendations are made regarding the best method for each kind of lumber. The book is well-illustrated, and there are a number of tables and charts to assist in determining the proper temperature and humidity in the kiln for drying the various kinds of lumber.

A TREATISE ON THE ELEMENTS OF ELECTRICAL ENGINEERING. A text-book for colleges and technical schools. By Wm. S. Franklin. Vol. 1. Pp. 465. Ill. Index. The Macmillan Company, New York, 1917. For sale by MINING AND SCIENTIFIC PRESS. Price, $4.50.

This is a companion to the work by the same author entitled 'Electric Lighting and Miscellaneous Applications of Electricity', which, as re-printed, will constitute Vol. 2 of 'The Elements of Electrical Engineering', thus making a very complete résumé of the essentials of practical electrical operations of the day. The present volume is divided into three parts, the first reviewing elementary and applied electricity and magnetism, which deals with ferro-magnetism and electro-magnetism, heating-effect of the electric current, induced electromotive force, the electric field, the electron theory, and other subjects. Part II deals with direct-current machines and systems, and plunges at once into the practical side of the question. Part III develops the elementary theory of the alternating-current, and Part IV deals with alternating-current machines and systems, including the alternator as a generator and as a motor, the conversion of alternating to direct-current, with problems and solutions, transformers, the induction-motor, the single-phase commutator-motor, and the general theory of transformers and induction-motors. While it deals with the simple physics of the subject, it must be stated that the use of the work requires a knowledge of calculus.

HEAT. By John Roger. 12mo. Pp. 77. Publishers Printing Co., New York, 1917. Privately printed.

The thesis presented in this book may best be summed up in the preferatory words of the author. He says that "Heat is a diamagnetic or negative force acting in opposition to the positive force of atomic attraction; that temperature is the negative atomic stress produced between the atoms; that the work-value of a unit of heat is 778 foot pounds, but is proportionate to the temperature; that the unit of energy, 778 foot pounds, may apply anywhere on the scale of temperature without reference to the unit of heat; that there is no such thing as latent heat, but that there is only developed and undeveloped energy; that the properties of different forms of matter can be compared by quantities of equal weight, but that the specific heat of different materials should be dealt with by equal volumes." He further affirms that "Gases do not expand proportionately to their pressure per square inch, but when expanded adiabatically the pressure varies inversely as the square of the distance between the atoms." He distinguishes between a gas and a vapor by a difference in the intensity of the force of attraction between the atoms, and he points out that the specific heat of matter has no apparent relation to the atomic weights. Since this is the work of a trained and highly accomplished physicist and mathematician, who yet knows how to use language as an expression of mathematical ideas without resort to symbols, which is a rare mental qualification, it is certain that Mr. Roger's book will be demanded by a large and interested public.

ELEMENTS OF WESTERN WATER LAW. By A. E. Chandler. Pp. 158. Index. The Technical Publishing Co., San Francisco. For sale by 'Mining and Scientific Press,' San Francisco. Price, $2.50.

The first edition of this useful treatise appeared nearly six years ago. Since that time, several important decisions have been rendered by the courts, and several equally important laws have been passed by the legislatures of the 'irrigation States.' For this reason the book has been thoroughly revised and brought up-to-date. The author, who is a member of the California State Water Commission, traces the development of the conflicting doctrines of appropriation and of riparian rights to the present time, when many of the Western States have abandoned the common-law doctrine entirely and the others have modified it considerably. This subject is closely related to the law of underground waters, which is also considered. The next chapters deal with water-right legislation and water-rights on interstate streams. The procedure for obtaining rights-of-way over public lands is then considered. Then follows a general discussion of commercial and co-operative irrigation enterprises, including irrigation districts, Carey Act projects, Reclamation Service projects, and land entered under the Desert Land Act. The final chapter is entitled 'The Desideratum in Legislation Regarding the Public Waters.' The treatment of the various subjects is non-technical. The book will be invaluable not only to the hydraulic engineer, but also to any one else concerned with the management or operation of irrigation or hydro-electric projects in the West.

New Publications

THE SUPPORTING STRENGTH OF SEWER-PIPE IN DITCHES AND METHODS OF TESTING SEWER-PIPE IN LABORATORIES TO DETERMINE THEIR ORDINARY SUPPORTING STRENGTH. By A. Marston, W. J. Schlick, and H. F. Clemmer. Bulletin No. 47, Engineering Experiment Station, Iowa State College, Ames, Iowa. Pp. 58. Ill. More fully reviewed on page 57 of this issue.

COST ACCOUNTING FOR OIL PRODUCERS. By Clarence G. Smith. Pp. 120. Index. Bulletin No. 158, U. S. Bureau of Mines. Discusses cost accounting in a clear non-technical way, and gives a number of specimen forms.

GEOLOGICAL STRUCTURE IN THE CUSHING OIL AND GAS FIELD, OKLAHOMA. By Carl H. Beal. Bulletin 658, U. S. Geological Survey. Pp. 61. Ill.

EIGHTH ANNUAL REPORT OF THE BOARD OF PUBLIC UTILITIES OF THE CITY OF LOS ANGELES. Pp. 218. Ill., index.

Engineering Societies

IDAHO SOCIETY OF ENGINEERS. Ira F. Schaffner, secretary, Boise.

Los Angeles Section of AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Ford W. Harris, secretary, 1029 Higgins building.

Los Angeles Section of AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Edward Woodbury, secretary, 255 East 3rd street.

OREGON SOCIETY OF ENGINEERS. Orrin E. Stanley, secretary room 409, City Hall, Portland.

Portland Section, AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Paul Lebenbaum, secretary, 45 Union Depot.

Portland Association of Members of AMERICAN SOCIETY OF CIVIL ENGINEERS. J. A. Currey, secretary, 194 North 13th street, Portland.

San Francisco Section of AMERICAN SOCIETY OF CIVIL ENGINEERS. N. A. Bowers, secretary, Rialto building.

San Francisco Section of AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Carl F. Braun, secretary, Hooker & Lent building.

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San Francisco Section of AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. A. G. Jones, 811 Rialto building.

Southern California Association of Members of AMERICAN SOCIETY OF CIVIL ENGINEERS. Wilkie Woodard, secretary, 435 Consolidated Realty building, Los Angeles.

UTAH SOCIETY OF ENGINEERS. Hugh C. Lewis, secretary, Capitol building, Salt Lake City, Utah.

A meeting of the SAN FRANCISCO SECTION OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS was held January 25. B. F. Jakobsen presented an abstract of his paper on 'Corona Test at High Altitude,' which appeared in full in the December 1917 Proceedings of the Institute.

A joint meeting of the SAN FRANCISCO ELECTRICAL DEVELOPMENT AND JOVIAN LEAGUE and the San Francisco Association of Members of the American Society of Civil Engineers was held January 30. H. J. Brunnier spoke on 'Co-operation Between Civil Engineers and Electrical Men,' C. D. Marx on 'The Relation of Technical Training to War-Time Activities,' and C. G. Hyde on 'The Relation of the University as an Institution to War-Time Activities.' N. A. Bowers presided.

A meeting of the OAKLAND ENGINEERS' CLUB was held January 16. George A. Posey, chief deputy county surveyor of Alameda county, gave a talk on the proposed joint railroad and highway bascule-bridge across the Oakland estuary.

A joint conference of agricultural, engineering, and irrigation societies of Idaho was held January 14 to 19 at Idaho Falls, Idaho.

Coming Conventions

AMERICAN ROAD BUILDERS' ASSOCIATION. Annual convention, St. Louis, February 4-7. E. L. Powers, secretary, 150 Nassau street, New York.

AMERICAN CONCRETE INSTITUTE. Annual meeting, Chicago, June 24-27. H. B. Alvord, secretary, 27 School street, Boston.

Personal

MARK L. REQUA has been appointed Federal Oil Administrator.

J. D. GALLOWAY, Major in the U. S. Army, has arrived in France.

WILLIAM GERIG has been appointed engineer in charge of the Anchorage division of the Alaska railroad.

R. A. BEEBEE has been appointed efficiency engineer for the Department of Public Affairs of Oakland, California.

JAMES T. NARBETT has been appointed Captain in the Engineer Officers' Reserve Corps, and is now in training at Camp Lee.

HERBERT NUNN, State highway engineer of Oregon, has been elected president of the Northwest Society of Highway Engineers.

E. T. THURSTON JR., Captain in the Engineer Officers' Reserve Corps, has been assigned to duty at Camp Devens, Ayer, Massachusetts.

MELVILLE DOZIER JR., formerly assistant general manager for the Northern Electric Railroad, has been appointed general manager for the California State Reclamation Board.

JOHN A. GRIFFIN, formerly assistant city engineer of Los Angeles, has been appointed Captain of Company A, 316th Engineers, and is now stationed at Camp Lewis, Washington.

ARTHUR N. TALBOT, head of the Department of Municipal and Sanitary Engineering at the University of Illinois, has been elected president of the American Society of Civil Engineers.

M. H. PECK, Captain in the 305th Engineers, sailed from New York early in January. Whether he went directly to France, or has been assigned to duty in England, is not known.

GUY E. TRIPP, chairman of the Westinghouse Electric & Manufacturing Co., has been appointed chief of the Production Division of the Ordnance Department, U. S. Army, with the rank of Colonel.

JAMES G. SCRUGHAM, formerly State engineer of Nevada, has resigned to become Major in the Ordnance Department, U. S. Army. SEYMOUR CASE, formerly deputy State engineer, has been appointed acting State engineer.

J. R. CHAPMAN has been appointed a member of the board of water commissioners of Santa Barbara, California. Mr. Chapman was for several years engineer for the company controlling the underground railroads of London.

F. EMERSON HOAR, engineer for the gas and electric department of the California State Railroad Commission, has been appointed Captain in the Engineer Officers' Reserve Corps and is now training at Camp Lee, Petersburg, Virginia.

FREDERICK MEARS, for the past four years member of the Alaskan Engineering Commission, and in charge of work at Anchorage, has been relieved at his own request to become colonel of a regiment of railroad engineers that will shortly be sent to France.

EDGAR H. ANNEAR, for the past 11 years county surveyor of Stanislaus county, California, has been appointed Captain in the Engineer Officers' Reserve Corps, and has reported for duty at Washington, D. C. Mr. Annear's most recent work in Stanislaus county was the design and construction of the county highway system. Of the 126 miles of concrete-paved roads comprising the system, between 80 and 90 miles has now been completed, and most of the rest of the other roads will be finished by April 1. J. H. HOSKINS will succeed Mr. Annear in general charge of the work of the county surveyor's office, and LLOYD ALDRICH will have charge of the completion of the highway system.

Commercial Paragraphs

Never before in the history of our country has the need been so urgent for the conservation and protection of machinery of all kinds. This applies more particularly to farm machinery and equipment for the reason that our crops are of paramount importance, and adequate machinery for their planting and harvesting is a prime essential. Protect new equipment from the elements. Repair and put into commission old equipment so as to eliminate unnecessary buying of new machinery, and thus spare metal and labor for war purposes. One of the most effective means for protecting and conserving machinery is the judicious application of a good preservative paint. Even in times of peace, farmers and others could save capital and increase their profits by a more generous use of preservative paint. It is surprising how much longer metal, wood, and other materials will last if given a coat of paint occasionally.

The CERRO DE PASCO MINING CO. of Peru has recently completed a 3000-kilowatt hydro-electric plant. Frank G. Baum of San Francisco had charge of the design and construction of the plant. Mr. Baum also had charge of the design and construction of a 4000-kilowatt hydro-electric plant recenty completed for the Homestake Mining Co. at Spearfish, South Dakota.

The ASSOCIATED TEAMING AND GRADING CONTRACTORS is the name of an organization recently formed in San Francisco. The officers are: Gordon Chamberlain, president; Frank O'Shea, vice-president; W. S. Scott, secretary; and Arthur Sibley, treasurer.

The firm of Ford, Bacon, & Davis, of New York, New Orleans, and San Francisco, has been incorporated under the name of the FORD, BACON & DAVIS CORPORATION. The engineering and contracting work of the firm will be continued under the same management as before.

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Construction News Summary

STREET AND ROAD WORK

ALAMEDA, CAL.—Contract for construction of concrete curbs and sidewalks on several streets has been awarded to Bernard Ransome, 28th and Poplar streets, Oakland.

ASTORIA, ORE.—J. H. Tillman Co. was low bidder and was awarded contract for construction of three miles between Astoria and Fort Stevens at $1.92 per sq. yd. for asphaltic concrete pavement on 5-in. concrete base.

BERKELEY, CAL.—Contract for construction of sidewalks on Francisco street has been awarded to Fred H. Austin.

BOISE, IDA.—Plans have been prepared for highway from Grangeville to New Meadows. Estimated cost is $800,000, which will be shared between the State and the Federal government.

CALEXICO, CAL.—G. R. Daley, who has contract for street improvements, has sublet contract for construction of sanitary sewers, and concrete sidewalks and curbs to Bush Construction Co. for $18,000.

COQUILLE, ORE.—Contract for macadamizing three miles of the Empire-South Slough road has been awarded to Dean & Brown, North Bend, at $0.40 per cu. yd. for excavation and $1.05 per cu. yd. for macadam, a total of $15,140.

DINUBA, CAL.—Contract for paving several streets has been awarded to Thompson Bros., Fresno.

EL SEGUNDO, CAL.—Bids will be received until February 13 by V. D. McCarthy, city clerk, for improvement of Ballona avenue and Main street, including 14,593 cu. yd. excavation and 295,532 sq. ft. asphaltic macadam pavement.

EUGENE, ORE.—Budget for 1918 in Lane county will include $160,000 for highway construction and maintenance.

FRESNO, CAL.—Plans are being considered by Board of Supervisors for expenditure of $2,000,000 on construction of county highways, including $425,000 for county's share of Hanford-San Lucas state highway lateral.

Contract for improvement of several streets has been awarded to Thompson Bros., Fresno.

HANFORD, CAL.—Contract for construction of 6¼ miles of asphaltic concrete highway south of Corcoran has been awarded to Raisch Improvement Co., Crocker Bdg., San Francisco. This is the last unit of the county highway system. The unit prices were as follows: excavation, $0.90 per cu. yd.; 2½-in. asphaltic concrete base, $0.05 per sq. ft.; 1½-in. topeka surface, $0.0298 per sq. ft.; guard-rail, $0.75 per foot.

HOLBROOK, ARIZ.—Contract for construction of Holbrook-Winslow road has been awarded to Tanner & Turley, Holbrook.

HONOLULU, HAWAII.—A. S. Cantin has prepared plans for highway improvement on island of Oahu costing $1,500,000.

MENLO PARK, CAL.—Contract for grading roads at Camp Fremont has been awarded to W. E. Price, Martinez.

LOS ANGELES, CAL.—Fred Hoffman, Long Beach, was the only bidder at $12,485 for improvement of Burr avenue in road district No. 107.

G. R. Curtis, Los Angeles, was the only bidder for paving part of Hope street at the following unit prices: grading, 20c. per sq. ft.; asphalt pavement, 20c. per sq. ft.; granite-block pavement, 50c. per sq. ft.; concrete sidewalks, 14c. per sq. ft.; granite-block gutters, 50c. per sq. ft.; concrete curbs, 30c. per foot.

Contract for grading and construction of macadam pavement and concrete curbs and gutters on Doheny drive has been awarded to Mathews Construction Co., Sherman, for $4199.47.

Contract for improvement of Cove avenue has been awarded to M. W. McCombs, 1654 West 36th street, Los Angeles, for $7404.46. Johnston & Grohs bid $7874.75.

Contract for grading and oiling Bates street has been awarded to W. Liddington, 420 East 60th street, Los Angeles, for $1419.88. Other bidders were: E. Schelling, $1776.69; W. F. Peck, $1983.07; Johnston & Grohs, $2594.42; M. S. Cummings, $3447.31.

Contract for grading and oiling Effie street has been awarded to Will F. Peck, 4568 Finley avenue, Los Angeles, for $3787.19.

MT. VERNON, WASH.—Bids will be received until March 5 by county commissioners for improvement of Pacific highway from Snohomish County line to Mt. Vernon.

Kaiser Construction Co., Everett, was low bidder at $62,888 for construction of the Olympia Marsh road. Skagit Construction Co., Mt. Vernon, bid $64,210. J. L. Smith Co. submitted conditional bid of $63,562.

MARTINEZ, CAL.—County surveyor R. R. Arnold is preparing plans for division No. 7 of county highway system, between Antioch and Byron, which is to be constructed during 1918.

Tony Albi, Martinez, was the only bidder at 19c. per sq. ft. for construction of concrete sidewalks on Main street.

MARSHFIELD, ORE.—Contract for paving Front street and Anderson avenue has been awarded to Moon & Gidley, Marshfield.

OAKDALE, CAL.—Contract for construction of topeka pavement on 4-in. asphaltic concrete base on part of F street has been awarded to Raisch Improvement Co., Crocker Bdg., San Francisco, the only bidders, at the following unit prices: pavement, $0.169 per sq. ft.; sidewalks, $0.159 per sq. ft.; concrete curbs, $0.50 per ft.; a total of about $8000.

OAKLAND, CAL.—Contract for improvement of part of 23rd street has been awarded to Oakland Paving Co., Oakland, at the following unit prices: concrete curbs, $0.75 per ft.; brick gutters, $0.45 per sq. ft.; asphalt pavement, $0.20 per sq. ft.; cast-iron inlets, $35 each.

OROVILLE, CAL.—Bids will be received until February 8 by C. F. Belding, county clerk, for improvement of Palermo road.

J. A. Huntington, 324 Montgomery street, Oroville, was low bidder and was awarded contract at 65c. per cu. yd. for grading Oroville-Bangor road between Oroville and Garden Ranch. Chico Contracting Co. bid 74c. per cubic yard.

Preliminary surveys for proposed state highway lateral from Oroville to Quincy by way of north fork of Feather river will be completed soon. Highway would start from present Concow road near Big Bar and follow the canyon at a considerable distance above the Western Pacific Railway grade to connect with the present Quincy-Greenville road, about 40 miles in all. Estimated cost is $600,000.

OLYMPIA, WASH.—Contract for grading and graveling National Park highway north from Ohop has been awarded to Torger Peterson, Eatonville, for $41,745. Allred & James bid $47,645.

S. Ward, Centralia, was only bidder at $51,137 for construction of National Park highway south from Ohop. Bids were rejected because too high.

PASCO, WASH.—Contract for construction of Pasco-Rattlesnake Flat road has been awarded to Porter & Conley, Portland, for $28,845.21.

All bids for surfacing part of the Central Washington highway and permanent highway No. 8 have been rejected. Plans for these two roads will be revised, and a new call for bids issued.

PHOENIX, ARIZ.—Contract for improvement of 7th avenue has been awarded to Southwestern Contracting Co. at $2 per sq. yd. for bitulithic pavement, $1.25 per ft. for combination concrete curb and gutter, and $0.70 per ft. for concrete curbs.

Contract for improvement of Adams street between Fifth and Ninth streets has been awarded to Southwestern Contracting Company.

Contract for improvement of Willetta street has been awarded to Southwestern Contracting Company.

PORTLAND, ORE.—Secretary of Agriculture has approved the co-operative agreement by which the Federal Government and the State Highway Commission will share in the cost of construction of the Pacific highway through Cow Creek canyon in Douglas county, 11.8 miles.

Proposed budget for highway construction and improvement in Multnomah county provides for the expenditure of $504,150.

PROSSER, IDA.—Contract for construction of macadam pavement on several streets, about one mile in all, has been awarded to O. S. Brown for $10,930.

RED BLUFF, CAL.—Bids will be received until February 8 by board of trustees of high school for construction of 6000 sq. ft. of concrete sidewalks and a 10,000-gal. concrete oil-tank.

RICHMOND, CAL.—Contract for improvement of 15th street has been awarded to E. Staniger, Richmond. There were four other bidders.

Contract for improvement of Beck street has been awarded to Fred Meyers, 120 South 23rd street, Richmond.

RIVERSIDE, CAL.—Plans for construction of 14 miles of

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graveled road and one mile of earth road in road improvement district No. 5 in Palo Verde valley have been adopted and call for bids will be issued soon.

Contract for construction of Wineville road has been awarded to Johnson-Shea Co., Riverside, for $8200.

Contract for construction of Cabazon-Whitewater highway has been awarded to R. Gill and W. J. Riley for $8056.20.

No bids were received for construction of highway in Temescal district and work will be done by day-labor under the direction of supervisor J. T. Hamner.

SACRAMENTO, CAL.—Fred Hoffman, Long Beach, was the only bidder for paving 26 miles of state highway in Los Angeles county between Kay ranch and Quail lake at $16.70 per cu. yd. for concrete in pavement, culverts, and retaining-walls, and $0.75 per ft. for guard-rail; a total of $575,130. Engineers' estimate was $378,879. State will furnish reinforcing-steel and cement, valued at $140,878. Bid was rejected because too high.

Contract for construction of 11 miles of state highway near San Lucas in Monterey county has been awarded to George S. Benson & Sons, Stimson Bdg., Los Angeles, for $104,772.50.

W. M. Ledbetter, Los Angeles, was the only bidder for construction of 3.7 miles of state highway in San Diego county near Sweetwater river at the following unit prices: excavation, $1.25 per cu. yd.; 18-in. and 24-in. corrugated pipe, $1 per ft.; 30-in. corrugated pipe, $1.25; concrete in culverts and monuments, $30.50 per cu. yd.; dry rubble masonry, $12 per cu. yd.; guard-rail, $1 per ft.; monuments, $1.25 each; a total of $77,993.50. Engineers' estimate was $64,526.88. State will furnish reinforcing-steel, pipe-railing, corrugated pipe, valued at $4044.01. Bid was rejected because too high and new bids will be received by State Highway Commission until February 18.

David H. Ryan, San Diego, was the only bidder and was awarded contract for construction of 4 miles of state highway in East San Diego and La Mesa at the following unit prices: excavation, $1.50 per cu. yd.; 18-in. corrugated pipe, $1 per ft.; 24-in. pipe, $1.50; concrete in culverts and monuments, $15 per cu. yd.; concrete in pavement, $7.40 per cu. yd.; guard-rail, $1 per ft.; monuments, $1.50 each; a total of $45,912. Engineers' estimate was $39,695.70. State will furnish pipe-railing, reinforcing-steel, corrugated pipe, and cement, valued at $17,560.20.

No bids were received for construction of 11 miles of state highway in Modoc county between Adin summit and Canby.

F. Rolandi, San Francisco, was the only bidder for construction of state highway in Lassen county between Coppervale and Susanville, 15 miles, at $81,027. Engineers' estimate was $66,827.

Contract for construction of concrete pavement on 13.25 miles of Grand Island road has been awarded by County Highway Commission to Healy-Tibbitts Construction Co., San Francisco, for $137,308.

State Highway Commission has ordered surveys of the Shandon-Antelope division of the state highway lateral between Famoso and Paso Robles.

SAN DIEGO, CAL.—O. Nelson was the only bidder and was awarded contract for improvement of Upas streets at 59c. per cu. yd. for excavation, 10c. per cu. yd. for embankment, 40c. per ft. for concrete curbs, 13.5c. per sq. ft. for concrete sidewalks, a total of $6029.68.

Contract for improvement of Imperial avenue has been awarded to Fairchild-Gilmore-Wilton Co., Pacific Electric Bdg., Los Angeles, at 18.5c. per sq. ft. for pavement and 40c. per ft. for curbs.

SAN FRANCISCO, CAL.—Board of Public Works has awarded the following contracts for street work:

Improvement of Judah street between 44th and 46th avenues to Owen McHugh, at the following unit prices: concrete curbs, $0.50 and $0.60 per ft.; asphalt pavement, $0.20 per sq. ft.; concrete sidewalks, $0.10 per sq. ft.; 8-in. sewers, $1.10 per ft.; 6-in. sewers, $1.25 per ft.; wye-branches on 8-in. sewer, $0.75 per ft.; brick manholes, $65 each; brick catch-basins, $90 each.

Improvement of Stark place from Stockton street to its easterly termination to V. Ellinwood at $0.42 per sq. ft. for asphalt pavement and $1.54 per ft. for granite curbs.

Improvement of Holloway avenue between Jules avenue and Faxon avenue and between Capitol avenue and Miramar avenue to S. F. Johnson at the following unit prices: asphalt pavement, $0.21 per sq. ft.; concrete sidewalks, $0.12 per ft.; concrete curbs, $0.75 per ft.; excavation, $0.50 per cu. yd.; embankment, $0.50 per cubic yard.

Improvement of Newman street to J. F. Dowling at the following unit prices: excavation, $0.65 per cu. yd.; concrete curbs, $0.75 per ft.; vitrified brick pavement, $0.42 per sq. ft.; asphalt pavement, $0.215 per sq. ft.; concrete sidewalks, $0.14 per square foot.

Mohawk avenue from Mission street to Huron avenue, to J. F. Dowling at the following unit prices: excavation, $0.85 per cu. yd.; concrete curbs, $0.75 per ft.; asphalt pavement, $0.22 per sq. ft.; 10-in. vitrified culvert, $1 per ft.; brick catch-basins, $90 each.

Naples street between Italy avenue and Amazon avenue to Thomas A. Clark at the following unit prices: concrete sidewalks, $0.12 per sq. ft.; concrete curbs, $0.75 per ft.; asphalt pavement, $0.215 per sq. ft.; brick catch-basins, $87.50 each; 10-in. vitrified culverts, $1.20 per ft.; 8-in. vitrified sewer, $0.75 per foot.

Sidewalks on Howard street between 10th and 11th to James T. Tobin at 11.5c. per square foot.

Sidewalks on Cook street near Geary to Frank O'Shea at 13.2c. per square foot.

Improvement of 48th avenue near Cabrillo street to State Improvement Co. at 88c. per ft. for concrete curbs, 26c. per sq. ft. for asphalt pavement, and 15.4c. per sq. ft. for concrete sidewalks.

Improvement of Edinburgh street between Peru and Silver avenues to H. Crummey, Inc., at the following unit prices: excavation, $0.70 per cu. yd.; concrete curbs, $0.70 per ft.; brick pavement, $0.38 per sq. ft.; asphalt pavement, $0.19 per sq. ft.; 8-in. sewer, $1.35 per ft.; wye-branches on 8-in. sewer, $1.50 per ft.; 6-in. sewer, $1.35 per ft.; brick manholes, $75 each.

Improvement of 46th avenue between Cabrillo and Fulton streets to Owen McHugh at the following unit prices: concrete curbs, $0.90 per ft.; asphalt pavement, $0.29 per sq. ft.; concrete sidewalks, $0.14 per square foot.

Improvement of 34th avenue between Anza and Balboa streets to John J. Calish at the following unit prices: concrete sidewalks, $0.15 per square foot; concrete curbs, $1 per ft.; asphalt pavement, $0.25 per square foot.

Improvement of Anza street between 34th and 35th avenues to M. A. Greely at the following unit prices: concrete curbs, $0.75 per ft.; asphalt pavement, $0.23 per sq. ft.; concrete sidewalks, $0.14 per square foot.

Improvement of Balboa street between 44th and 45th avenues to H. Crummey, Inc., at the following unit prices: brick catch-basins, $85 each; 10-in. vitrified culverts, $1.50 per ft.; concrete curbs, $0.60 per ft.; concrete sidewalks, $0.11 per sq. ft.; basalt-block header on concrete foundation, blocks to be furnished by city, $0.26 per sq. ft.; asphalt pavement, $0.19 per square foot.

Improvement of Vienna street between Italy and Amazon avenues to S. F. Johnson at the following unit prices: concrete curbs, $0.80 per ft.; asphalt pavement, $0.235 per sq. ft.; concrete sidewalks, $0.14 per sq. ft.; brick catch-basins, $90 each; 10-in. vitrified culverts, $1.25 per ft.; 8-in. vitrified sewer, $1.50 per foot.

Improvement of 38th avenue between Geary and Anza streets to M. A. Greely at the following unit prices: embankment, $1.75 per cu. yd.; concrete curbs, $0.80 per ft.; brick pavement, $0.42 per sq. ft.; asphalt pavement, $0.24 per sq. ft.; concrete sidewalks, $0.15 per square foot.

Section A of the Marina boulevard to Felix McHugh at the following unit prices: excavation, $0.40 per cu. yd.; embankment, $0.40 per cu. yd.; 10-in. vitrified culvert, $1 per ft.; 12-in. sewer, $1.50 per ft.; 15-in. sewer, $1.90 per ft.; wye-branches on 15-in. sewer, $1.90 each; brick manholes, $75 each; brick catch-basins, $80 each; moving existing catch-basins, $25 each; brick gutters, $0.38 per sq. ft.; 2-in. topeka pavement on 6-in. concrete base, $0.18 per sq. ft.; basalt-block gutters, $0.45 per sq. ft.; basalt-block pavement on sand, $0.37 per sq. ft.; reconstruction of basalt-block pavement, $0.25 per ft.; armored concrete curbs, $0.64 per ft.; concrete sidewalks, $0.11 per ft.; hauling granite curbs to corporation yard, $1.50 per ton.

City engineer M. M. O'Shaughnessy has completed plans for paving Columbus avenue between Montgomery street and North Point street.

SAN LUIS OBISPO, CAL.—Board of Supervisors has passed resolution providing for raising each year by direct taxation one-fourth of the county's share of the cost of construction of the state highway lateral from Paso Robles to Famoso.

SANTA ANA, CAL.—Orange County Engineering & Construction Co., Santa Ana, was the only bidder and was awarded the contract for paving part of West Fourth street at $0.175 per sq. ft., or $1041 in all.

Contract for construction of concrete pavement at Laguna Beach has been awarded to Steele Finley, Santa Ana, for $2761.80.

SANTA BARBARA, CAL.—Contract for construction of

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three miles of highway between Los Olivos and Zaca Station has been awarded to R. M. Davis for $12,851.20. Ira Hodson bid $16,676.40. Work will require 29,000 cu. yd. excavation.

SANTA ROSA, CAL.—Contract for grading road near Dibble ranch, which was awarded to W. L. Proctor, has been rescinded, and work will be done by day-labor.

Board of Supervisors has decided to construct road from Guerneville to Monte Rio along north side of river.

SEATTLE, WASH.—County engineer S. Humes has completed plans for 20 miles of paved highways to be constructed this year. Estimated cost is $350,000.

Plans have been prepared for construction of brick pavement on West Spokane street. Estimated cost is $150,000.

SOUTH BEND, WASH.—Bids will be received until February 8 by county commissioners for the following highway work: Clearing, grubbing, grading, and draining the Bale road, one mile. Clearing and grubbing one-half mile of Peninsula highway. Macadamizing Columbia-North Bank highway.

SPOKANE, WASH.—Budget for 1918 in Spokane county includes $225,000 for construction of surfaced highways.

TACOMA, WASH.—Plans have been completed by D. H. White, county engineer, for paving the following roads: 3.4 miles of National Park highway, 2 miles of highway near Orting, 1 mile of highway near Buckley, and 1½ miles of highway near Puyallup; also grading and graveling 2 miles of highway near Steilacoom. Call for bids will be issued soon.

Contract for improvement of several streets has been awarded to Joseph Warter, Sr., Tacoma, for $18,917.

TULARE, CAL.—Contract for improvement of 2.3 miles of streets has been awarded to Federal Construction Co., Sharon Bdg., San Francisco, at $0.01 per cu. yd. for excavation, and $11.25 per cu. yd. for concrete pavement, a total of about $37,000. Other bidders were: Kaufield & Tompkins at $2.25 per cu. yd. for excavation and $9 per cu. yd. for concrete; C. E. Bennett, $0.91 and $12.50; Frank C. McIntire, $0.85 and $11.90; J. S. Caldwell, $1 and $12.

VALLEJO, CAL.—Plans have been completed and resolution of intention adopted for construction of concrete sidewalks in various parts of the city. Estimated cost is $9135.

VISALIA, CAL.—Following bids were received for construction of 8.4 miles of county highway between Three Rivers and Lemon Cove: Highway Construction Co. (awarded contract), $1.25 per cu. yd. for excavation, $3.25 per cu. yd. for concrete, and $0.10 per cu. yd. per 100 ft. for overhaul. Concrete Pipe & Construction Co. bid $1.25, $4.30, and $0.02. Bent. Bros. bid $1.82 and $4.52, with no bid on overhaul. Federal Construction Co. bid $0.98 and $6.22, with no bid for overhaul.

Contract for surfacing county highway from Lindsay to Richgrove has been awarded to A. Teichert & Son, Sacramento.

WATERVILLE, WASH.—Plans have been completed by R. F. Foster, county engineer, for grading and surfacing permanent highway No. 1-A, 4 miles. Call for bids will be issued soon.

WENATCHEE, WASH.—Bids will be received until February 7 by county commissioners for paving two miles of permanent highway No. 10 with concrete.

YREKA, CAL.—Contract for construction of Sanborn Hill road has been awarded to F. S. Henderson, Fort Jones, for $6400. E. A. Hayden, Callahan, was the only other bidder.

SEWERS AND DRAINAGE

EUREKA, CAL.—City engineer A. G. Strand has recommended extensive changes in sewer system.

GRASS VALLEY, CAL.—Bids will be received until February 8 by C. F. Lobecker, city clerk, for laying 585 ft. of 6-in. sewer on Stewart street.

JEROME, ARIZ.—Bids will be received until February 20 by city clerk for construction of sewer system, including 3100 ft. of 12-in. and 10,200 ft. of 8-in. sewer, and three Imhoff tanks. Estimated cost is $40,000. Olmsted and Gillelen, Los Angeles, are engineers.

KING CITY, CAL.—Plans for sewage-disposal plant prepared by city engineer, J. E. Olive, including septic tank and filter-bed, have been accepted and call for bids will be issued soon.

LONG BEACH, CAL.—All bids for construction of sewers in district No. 1 have been rejected.

James West, Los Angeles, was low bidder and was awarded contract at $31,487 for construction of 6-in. and 8-in. cement sewers in district No. 7. Other bidders were: B. Z. Wucetich, $32,658.93; Johnson-Shea Co., $35,778.53; Leo Miletich, $35,993.98; J. S. Ukropina, $37,364.03.

LOS ANGELES, CAL.—Contract for construction of vitrified-pipe sewer on Wilcox avenue has been awarded to Adam Dalmatin for $5883.

MONTEREY PARK, CAL.—Superior Court has ruled that municipality has jurisdiction over land purchased by cities of Pasadena, South Pasadena, and Alhambra for a sewer-farm, and can prohibit its use for that purpose. Case will be appealed.

OAKLAND, CAL.—Contract for construction of sewer on 85th avenue has been awarded to J. Catucci, 1212 18th avenue, Oakland, at $0.84 per ft. for 8-in. sewer, $0.50 each for wye-branches, and $18 each for lamp-holes.

ONTARIO, ORE.—Contract for construction of drainage system for Ontario irrigation district, comprising 3 miles of open ditches and 11½ miles of tile-drains has been awarded to J. R. Hoskins and L. R. Stockman, Baker, for $150,000.

RICHMOND, CAL.—Plans have been completed for outfall sewer serving north-western part of city.

SANTA ANA, CAL.—Petition has been filed for formation of drainage district containing 30,000 acres of land near Norwalk. Estimated cost of work is $250,000.

SANTA BARBARA, CAL.—No bids were received for construction of plant for screening sewage and a new call for bids will be issued.

BRIDGES AND CULVERTS

BELLINGHAM, WASH.—Contract for construction of earth approaches to Prospect Street bridge has been awarded to K. Sauset for $2972.

EUREKA, CAL.—Contract for construction of steel suspension-bridge across Eel river at Alderpoint has been awarded to Mercer-Fraser Co., Eureka, for $76,582. F. L. Smith bid $78,975 and Midland Bridge Co., $94,000. On the alternate plans for an arch-bridge the bids were as follows: F. L. Smith, $86,897.50; Mercer-Fraser Co., $93,500; Midland Bridge Co., $94,000.

All bids for construction of bridges over Mad river at Mountain View and Hyampom have been rejected because too high.

EVERETT, WASH.—Contract for repair of Home Acres trestle has been awarded to H. S. Wright, Everett, for $28,400.

Contract for construction of steel bridges at Index and at Granite Falls has been awarded to Coast Bridge Co., Portland, for $25,000.

HANFORD, CAL.—Contract for construction of bridge south-east of Corcoran has been awarded to S. G. Smartt, Bakersfield, for $1872.

LEWISTON, IDA.—Contract for construction of bridge across Musselshell river at Mosby has been awarded to Iowa Bridge Co., for $16,438.

MODESTO, CAL.—Bids will be received until February 11 by H. Benson, county clerk, for construction of a concrete bridge over Snake creek near La Grange and for construction of a concrete culvert and five concrete siphons in various parts of the county.

Contract for construction of four concrete flat-slab bridges on county highways has been awarded to C. E. Cotton, 16 California street, San Francisco, for $16,720.

Contract for construction of six concrete siphons has been awarded to Frank C. McIntyre, Stockton.

OAKLAND, CAL.—Board of Supervisors has decided to proceed with construction of bascule bridge across Oakland estuary, in spite of the uncertainty regarding steel deliveries.

OLYMPIA, WASH.—Hans Pederson, Seattle, has been awarded contract for construction of reinforced concrete bridge across Nisqually river near La Grand, for $47,719. Other bidders were: Pacific States Construction Co., $49,575; E. G. Peters Co., $53,212; Charles Huber, $65,090; J. R. Wood, $68,045; H. C. Mallott, $68,694.

SALINAS, CAL.—No bids were received for construction of trestle-bridge across Lewis creek.

SAN JOSE, CAL.—Plans have been completed by city engineer, G. Walter Hunt, for construction of bridge over Coyote creek to replace the one that failed recently. Estimated cost is $55,000.

SANTA BARBARA, CAL.—Southern Pacific Co. will construct viaduct to eliminate grade-crossings on State highway. Estimated cost is $12,000.

SANTA ROSA, CAL.—Contract for construction of two concrete bridges has been awarded to W. L. Proctor, 1000 Spring street, Santa Rosa, at $2184.80 for bridge at Wilfred station, $2768.60 for bridge over Copeland creek, and $7.50 per cu. yd. for extra concrete at both bridges. There were five other bidders.

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County surveyor M. R. Youker is preparing plans for bridge across Russian river at Geyserville.

SONOMA, CAL.—Contract for construction of reinforced concrete bridge over Nathanson creek at Washington street has been awarded to Bordwell & Zimmerman, Calistoga, for $1780. C. H. Gildersleeve bid $1790.

TACOMA, WASH.—County engineer D. H. White is preparing plans for steel bascule-bridge over Hylebos creek. Estimated cost is $60,000.

IRRIGATION AND WATER SUPPLY

EUREKA, CAL.—Superintendent of public works, O. W. Lord, has recommended construction of concrete storage-dam on Elk river.

LOS BANOS, CAL.—State Board of Health has ordered West San Joaquin Water Co. to construct water-purification plant.

MEDFORD, ORE.—Plans for irrigation system for Medford irrigation district have been prepared by W. C. Hammatt, Hearst Bdg., San Francisco. Estimated cost is $1,600,000. Plans include dam 70 ft. high on Beaver creek, and system of gravity canals.

NEWMAN, CAL.—Formation of irrigation district containing 427,000 acres of land in Fresno, Merced, and Stanislaus counties is proposed. This district would acquire the Miller & Lux canals, the Stevinson canal, and the Patterson pumping system, and would construct extensions. W. W. Cox, Westley, L. McAulay, Crows Landing, and W. Jepson, Gustine, are interested.

PALMDALE, CAL.—Contract for construction of concrete-pipe irrigation system on 320-acre ranch of Guy C. Earl has been awarded to Albert S. Horton, Palmdale, at the following unit prices: 8-in. pipe, $0.205 per ft.; 8-in. slide-gates, $3.30 each; 8-in. screw pressure-gates, $6.60 each; 6-in. orchard valves, $2.25 each; 8-in. stand-pipe, $0.75 per foot.

PHOENIX, ARIZ.—Carl F. Schader, Van Nuys Bdg., Los Angeles, is interested in plan for irrigation of 15,000 acres of land in this vicinity. Plans include pumping plant, diversion dam, and canal system.

RED BLUFF, CAL.—Contract for construction of concrete pipe for J. M. Howell ranch has been awarded to R. A. Dotson, Oroville, for $4000.

SALEM, ORE.—State engineer John H. Lewis has approved plans for the construction of irrigation system for the Big Bend irrigation district comprising 5104 acres in Malheur county.

SAN FRANCISCO, CAL.—Plans have been completed and call for bids will be issued soon for hauling and laying high-pressure water-mains on Clarendon avenue. Estimated cost is $3700.

State Water Commission has received the following application for permission to divert water for irrigation:

Sespe Light & Power Co., Los Angeles, 60,000 acre-feet from Piru creek in Ventura county. Plans include canal 18 miles long.

Blevins-Mallon Ditch Co., Colusa, 60 second-feet of water draining from rice-fields. Plans include pumps operated by electric motors. Estimated cost is $18,300.

Thomas O'Brien, Lebec, flood-water from Piru creek. Plans include wooden dam and ditch 2¼ miles long.

Knox & Leiser, Grafton, 10 second-feet from Sacramento river.

State Water Commission has issued the following permits to divert water for irrigation:

J. L. Giroux, Dyer, Nevada, 6 second-feet for streams in Mono county. Plans include concrete-lined ditch 8644 ft. long. Estimated cost is $8000.

J. A. Mathews, Fort Jones, 70 second-feet from Scott river. Plans include ditch 20 miles long. Estimated cost is $45,000.

H. J. Lawrence, Palo Verde, 2 second-feet from Palo Verde lagoon. Plans include pump and canal one mile long. Estimated cost is $2000.

SAN JUAN, CAL.—C. C. Morse & Co., San Francisco, will construct irrigation system on their seed-farm near here. Estimated cost is $35,000. Cast-iron pipe will be used.

SAN PEDRO, CAL.—Thomas Haverty Co., Los Angeles, was low bidder at $14,800 for construction of water and gas distributing systems at Fort MacArthur. Bids were also received from S. Hill & Son and from the Turner Company.

SAN RAFAEL, CAL.—Bids will be received until 7.30 p.m., February 7, by secretary Marin Municipal water district for construction of 24-in. concrete pipe-line from Fairfax gate-house to Phoenix gate-house, including 313 cu. yd. concrete in trestles, 69 cu. yd. concrete in piers, 36,315 lin. ft. of trenching and backfilling, and 37,500 lin. ft. of 24-in. pipe. In addition it is estimated that 1000 cu. yd. material will have to be removed as a result of slides in the trench. Plans may be obtained from the secretary of the district upon deposit of $10.

Marin Municipal water district will take over the contract of Leonard & Hansen for construction of the Alpine dam. Work will be completed under the direction of A. R. Baker, engineer for the district.

TRACY, CAL.—All bids for construction of reinforced concrete siphons for West Side irrigation district have been rejected.

WAITSBURG, WASH.—Contract for construction of water system has been awarded to G. H. Sutherland Co., Walla Walla, for $34,577. There were ten other bidders.

LIGHT, HEAT, AND POWER

FRESNO, CAL.—Contract for construction of ornamental lighting system on Kearny avenue has been awarded to Lewis Electrical Co., Fresno, for $18,300.

LOS ANGELES, CAL.—Following bids were received for construction of lighting system on Broadway: Keystone Iron Works, $65,953; Reynard & Stary, $71,668; F. E. Newberry Electric Co., $82,343.

MARTINEZ, CAL.—Grand Jury has reported in favor of remodeling heating-system in courthouse and county jail.

PORTLAND, ORE.—Contract for construction of power-plant for Northwestern Electric Co. has been awarded to Charles C. Moore & Co., San Francisco. Estimated cost is $1,500,000.

SALT LAKE CITY, UTAH.—Joseph Lippman, 462 South 10th street East, Salt Lake City, and Herman Strauss have applied to State engineer for permission to divert 200 second-feet of water from Duchesne river for power. Plans include concrete diversion-dam, 60-in. wood-stave pipe-line 32,000 ft. long, and two 4500-hp. turbines.

SAN FRANCISCO, CAL.—State Water Commission has received the following applications for permission to divert water for power purposes:

Fresno Flume & Lumber Co., Clovis, water from tributaries of San Joaquin river. Plans include enlargement of existing reservoir at Shaver lake and 4½ miles of main ditch and canal.

Richard Phelan, Sierra City, water from tributary of Yuba river. Plans include 600 ft. of pipe-line.

State Water Commission has issued permit to J. G. Van Zandt, Los Angeles, to divert water from tributaries of Santa Ana river for power. Plans include conduit five miles long.

Southern California Edison Co. has applied to State Water Commission for permission to divert water from Pitman creek in Fresno county and from Salmon and Horse creeks in Tulare county. The work on Pitman creek will comprise a multiple-arch reinforced concrete dam, 103 ft. and 860 ft. long on top and a conduit to the Big Creek reservoir. The estimated cost is $842,900. The work on Salmon and Horse creeks includes a reservoir costing $181,635 to increase the supply of water delivered to the company's Kern River power-plant No. 3.

SEATTLE, WASH.—Bids will be received until March 1 by city commissioners for construction of municipal hydro-electric plant on Skagit river. Estimated cost is $5,000,000.

RIVER AND HARBOR WORK

LONG BEACH, CAL.—Contract for construction of reinforced concrete sea-wall on Seaside boulevard has been awarded to Ross Construction Co., Sacramento, for $111,775.

NEWPORT, ORE.—Contract for construction of south jetty at Yaquina bay has been awarded to Miami Construction Co., Portland, for $390,000. Robert Wakefield bid $406,000.

RICHMOND, CAL.—Contract for dredging turning-basin and channel in inner harbor has been awarded to American Dredging Co., San Francisco, for $44,280. North American Dredging Co. bid $46,710, and San Francisco Bridge Co., $47,790.

SAN DIEGO, CAL.—Following bids were received for dredging about 2,000,000 cu. yd. of material at harbor: San Francisco Bridge Co., San Francisco, 14.6c. per cu. yd. on work according to specifications and 13.9c. in case the bulkhead is moved 950 ft. inland. Western Dredging & Marine Construction Co., Long Beach, 14.85c. Contract was awarded to San Francisco Bridge Co. on the 13.9c. basis.

SANTA ANA, CAL.—Leeds & Bannard, Los Angeles, have been authorized to prepare plans for improvement of Newport harbor.

SEATTLE, WASH.—Bids will be received until February 15 at U. S. Engineer Office for dredging in Lake Washington ship-canal.

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